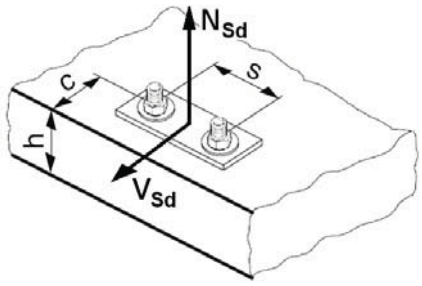
Design example

Adhesive anchoring system with variable embedment depth in non-cracked concrete

Anchoring conditions

concrete	Non-cracked concrete C50/60		
service temperature range of base material	temperature range II		
number of anchors	Group of two anchors close to the edge		
base material thickness		h	100 mm
anchor spacing		s	150 mm
edge distance		c	100 mm
shear load direction perpendicular to free edge		β	0 °
TENSION design action (fixing point)		N_{Sd}	15,0 kN
SHEAR design action (fixing point)		V_{Sd}	15,0 kN
TENSION design action per anchor		$N_{Sd}^{(1)}$	7,5 kN
SHEAR design action per anchor		$V_{Sd}^{(1)}$	7,5 kN
effective anchorage depth		h_{ef}	70 mm



anchor	Hilti HIT-RE 500-SD with HIT-V 5.8, size M12		
external diameter		d	12 mm
typical anchorage depth		$h_{ef,typ}$	110 mm
minimum edge distance		s_{min}	60 mm
minimum spacing		c_{min}	60 mm

The parameters are given in the anchor-section in the tables “setting details” and “setting parameters” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Critical spacings and edge distances

critical spacing for concrete cone failure $s_{cr,N}$ and critical spacing for combined pull-out and concrete cone failure $s_{cr,Np}$			
h_{ef} =	70 mm	$s_{cr,N} = s_{cr,Np} = 3\ h_{ef}$ =	210 mm

critical edge distance for concrete cone failure $c_{cr,N}$ and critical edge distance for combined pull-out and concrete cone failure $c_{cr,Np}$			
h_{ef} =	70 mm	$c_{cr,N} = c_{cr,Np} = 1{,}5\ h_{ef}$ =	105 mm

critical edge distance for splitting failure						
		for $h \le 1{,}3\ h_{ef}$		$c_{cr,sp} = 2{,}26\ h_{ef}$		
		for $1{,}3\ h_{ef} < h < 2\ h_{ef}$		$c_{cr,sp} = 4{,}6\ h_{ef} - 1{,}8\ h$		
		for $h \ge 2\ h_{ef}$		$c_{cr,sp} = 1{,}0\ h_{ef}$		
h =	100 mm	h_{ef} = 70 mm	h/h_{ef} =	1,43	→ $c_{cr,sp}$ =	142 mm

critical spacing for splitting failure			
$c_{cr,sp}$ =	142 mm	$s_{cr,sp} = 2\ c_{cr,sp}$ =	284 mm

General remarks

According EOTA Technical Report TR 029, concrete cone, combined concrete cone and pull-out, splitting, pryout and concrete edge design resistance must be verified for the anchor group. Steel design resistance must be verified for the most unfavourable anchor of the anchor group.

According to the simplified design method given in this Fastening Technology Manual all anchors of a group are loaded equally, the design resistance values given in the tables are valid for one anchor.

Tension loading

Design steel resistance

						$N_{Rd,s}$ =	**28,0 kN**

See “basic design tensile resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Design combined pull-out and concrete cone resistance

basic resistance						$N^0_{Rd,p}$	29,9 kN
concrete			Non-cracked concrete C50/60			$f_{B,p}$	1,09
h_{ef} =	70 mm	$h_{ef,typ}$ =	110 mm	$f_{h,p} = h_{ef}/h_{ef,typ}$ =			0,64
c =	100 mm	$c_{cr,N}$ =	105 mm	$c/c_{cr,N}$ =	0,95 →	$f_{1,N}$	0,99
						$f_{2,N}$	0,97
s =	150 mm	$s_{cr,N}$ =	210 mm	$s/s_{cr,N}$ =	0,71 →	$f_{3,N}$	0,86
h_{ef} =	70 mm				→	$f_{re,N}$	1,00
						$N_{Rd,p} = N^0_{Rd,p}\ f_{B,p}\ f_{1,N}\ f_{2,N}\ f_{3,N}\ f_{h,p}\ f_{re,N}$ =	**17,1 kN**

See “basic design tensile resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Design concrete cone resistance

basic resistance						$N^0_{Rd,c}$	32,4 kN
concrete			Non-cracked concrete C50/60			f_B	1,55
h_{ef} =	70 mm	$h_{ef,typ}$ =	110 mm	$f_{h,N} = (h_{ef}/h_{ef,typ})^{1,5}$ =			0,51
c =	100 mm	$c_{cr,N}$ =	105 mm	$c/c_{cr,N}$ =	0,95 →	$f_{1,N}$	0,99
						$f_{2,N}$	0,97
s =	150 mm	$s_{cr,N}$ =	210 mm	$s/s_{cr,N}$ =	0,71 →	$f_{3,N}$	0,86
h_{ef} =	70 mm				→	$f_{re,N}$	1,00
						$N_{Rd,c} = N^0_{Rd,c}\ f_B\ f_{h,N}\ f_{1,N}\ f_{2,N}\ f_{3,N}\ f_{re,N}$ =	**21,1 kN**

See “basic design tensile resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12) and “influencing factors” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Influencing factors may be interpolated.

Design splitting resistance

basic resistance						$N^0_{Rd,c}$	32,4 kN
concrete			Non-cracked concrete C50/60			f_B	1,55
h_{ef} =	70 mm	$h_{ef,typ}$ =	110 mm	$f_{h,N} = (h_{ef}/h_{ef,typ})^{1,5}$ =			0,51
c =	100 mm	$c_{cr,sp}$ =	142 mm	$c/c_{cr,sp}$ =	0,70 →	$f_{1,sp}$	0,91
						$f_{2,sp}$	0,85
s =	150 mm	$s_{cr,sp}$ =	284 mm	$s/s_{cr,sp}$ =	0,53 →	$f_{3,sp}$	0,76
h_{ef} =	70 mm				→	$f_{re,N}$	1,00
						$N_{Rd,sp} = N^0_{Rd,c}\ f_B\ f_{h,N}\ f_{1,sp}\ f_{2,sp}\ f_{3,sp}\ f_{re,N}$ =	**15,0 kN**

See “basic design tensile resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12) and “influencing factors” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Influencing factors may be interpolated.

Tension design resistance: lowest value	N_{Rd} =	**15,0 kN**

Shear loading

Design steel resistance

				$V_{Rd,s}$ =	**16,8 kN**

See “basic design shear resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Concrete pryout design resistance

lower value of $N_{Rd,p}$ and $N_{Rd,c}$				V^0 =	17,1 kN
h_{ef} =	70 mm		→	k	2
				$V_{Rd,cp} = k\ V^0$ =	**34,3 kN**

See “basic design shear resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12) and “influencing factors” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Concrete edge design resistance

basic resistance						$V^0_{Rd,c}$	11,6 kN
concrete		Non-cracked concrete C50/60				f_B	1,55
shear load direction perpendicular to free edge				0 °	→	f_β	1,00
h =	100 mm	c =	100 mm	h/c =	1,00 →	f_h	0,82
c =	100 mm	h_{ef} =	70 mm	c/h_{ef} =	1,43 →	f_4	1,28
s =	150 mm	h_{ef} =	70 mm	s/h_{ef} =	2,14		
h_{ef} =	70 mm	d =	12 mm	h_{ef}/d =	5,83 →	f_{hef}	0,97
c =	100 mm	d =	12 mm	c/d =	8,33 →	f_c	0,67
					$V_{Rd,c} = V^0_{Rd,c}\ f_B\ f_\beta\ f_h\ f_4\ f_{hef}\ f_c$ =		**12,3 kN**

See “basic design shear resistance” (for HIT-RE 500-SD with HIT-V 5.8, size M12) and “influencing factors” (for HIT-RE 500-SD with HIT-V 5.8, size M12)

Influencing factors may be interpolated.

Shear design resistance: lowest value	V_{Rd} =	**12,3 kN**

Combined tension and shear loading

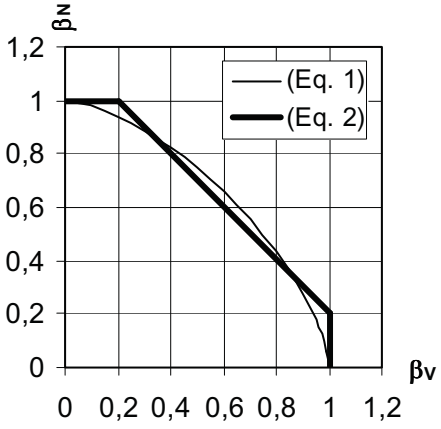
The following equation must be satisfied for combined tension and shear loads:

(Eq. 1) $(\beta_N)^{1,5} + (\beta_V)^{1,5} \le 1$

β_N (β_V) ratio between design action and design resistance for tension (shear) loading

According to ETAG 001, Annex C, the following simplified equation may be applied:

(Eq. 2) $\beta_N + \beta_V \le 1{,}2$ and $\beta_N \le 1$, $\beta_V \le 1$



Example (load values are valid for one anchor)

$N_{Sd}^{(1)}$ =	7,5 kN	$\beta_N = N_{Sd}^{(1)}/N_{Rd}$ =	0,500	≤ 1	✓
$V_{Sd}^{(1)}$ =	7,5 kN	$\beta_V = V_{Sd}^{(1)}/V_{Rd}$ =	0,612	≤ 1	✓
		$\beta_N + \beta_V$ =	1,112	≤ 1,2	✓
N_{Rd} =	15,0 kN				
V_{Rd} =	12,3 kN	$(\beta_N)^{1,5} + (\beta_V)^{1,5}$ =	0,832	≤ 1	✓