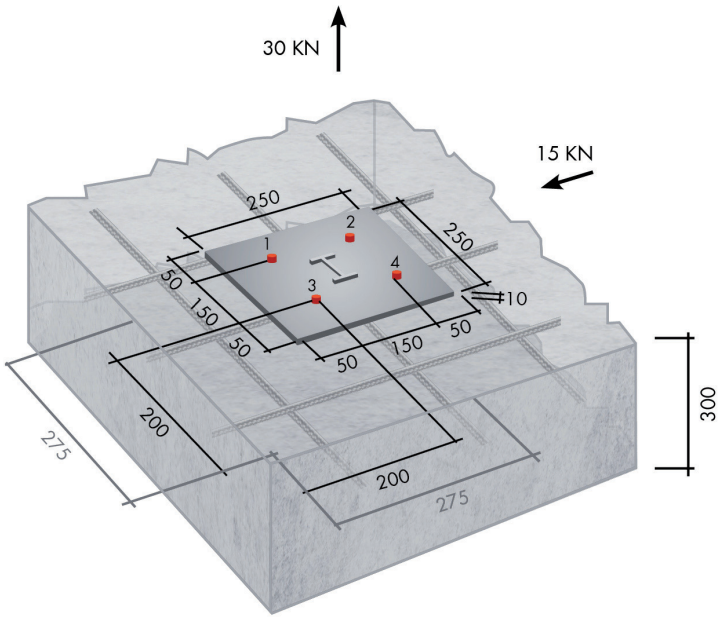
DESIGN TEMPLATE – MECHANICAL ANCHORS



Actions			
Design value of tensile load	N^g_{ed} =	30	kN
Number of anchors in the group loaded with tension	n =	4	
Design value of tensile load acting on a single anchor	$N^h_{ed} = N^g_{ed}/n$ =	7.5	kN
Design value of shear load	V^g_{ed} =	15	kN
Number of anchors in the group loaded with shear	n =	4	
Design value of shear load acting on a single anchor	$V^h_{ed} = V^g_{ed}/n$ =	3.75	kN
Anchor data			
Anchor type		W-FAZ/A4 M12	
Anchor diameter	M	12	
Anchorage depth	h_{ef} =	70	
Base material			
Compressive strength class of concrete			
Characteristic compressive cube strength of concrete at 28 days	$f_{ck,cube}$ =	37	N/mm²
Characteristic compressive cube strength of concrete at 28 days	$f_{ck,cyl}$ =	30	N/mm²
Cracked concrete ✔	**Non-cracked concrete**		

Structural verification			
Tension		**Shear**	
$\beta_{N,s}$ =	$N^h_{Ed} / N_{Rd,s}$	$\beta_{V,s}$ =	$V^h_{Ed} / V_{Rd,s}$
$\beta_{N,s}$ =	28 %	$\beta_{V,s}$ =	16 %
$\beta_{N,p}$ =	$N^h_{Ed} / N_{Rd,p}$	$\beta_{V,cp}$ =	$V^h_{Ed} / V_{Rd,cp}$
$\beta_{N,p}$ =	57 %	$\beta_{V,cp}$ =	13 %
$\beta_{N,c}$ =	$N^h_{Ed} / N_{Rd,c}$	$\beta_{V,cp}$ =	$V^h_{Ed} / V_{Rd,cp}$
$\beta_{N,c}$ =	62 %	$\beta_{V,cp}$ =	62 %
$\beta_{N,sp}$ =	$N^h_{Ed} / N_{Rd,sp}$		
$\beta_{N,sp}$ =	0 %		

I - Required verification of post-installed anchor in combined tension and shear load:		
Assessment of steel failure only		
	Utilization	**Verification**
Tension	28 %	$\beta_{N,max} \leq 1.00$
Shear	16 %	$\beta_{V,max} \leq 1.00$
Tension/shear combination	10 %	$\beta_{N,max}^{2.0} + \beta_{V,max}^{2.0} \leq 1.00$
II - Required verification of post-installed anchor in combined tension and shear load:		
Assessment of failure modes other than steel		
	Utilization	**Verification**
Tension	62 %	$\beta_{N,max} \leq 1.00$
Shear	62 %	$\beta_{V,max} \leq 1.00$
Tension/shear combination	98 %	$\beta_{N,max}^{1.5} + \beta_{V,max}^{1.5} \leq 1.00$

A. Required verification of post-installed anchor in tension				
1. Steel failure				
$N_{Rd,s}$	=	**26.7**	**kN**	
$\beta_{N,s}$	=	28	%	
2. Pull-out				
$N_{Rd,p}$	=	$N^0_{Rd,p} \cdot f_{b,N}$		
a. Influence of concrete strength				
$f_{b,N}$	=	1.22		
$N^0_{Rd,p}$	=	10.70	kN	
$N_{Rd,p}$	=	**13.05**	**kN**	
$\beta_{N,p}$	=	57	%	

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3. Concrete breakout

$$N_{Rd,c} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{sx} \cdot f_{sy} \cdot f_{cx,1} \cdot f_{cx,2} \cdot f_{cy}$$

$N^0_{Rd,c}$	=	13.4								
a. Influence of concrete strength										
$f_{b,N}$	=	1.22								
b. Influence of spacing										
$s_{cr,N}$	=	210	mm							
s_x	=	150	mm	$s_x / s_{cr,N}$	=	0.71		f_{sx}	=	0.86
s_y	=	150	mm	$s_y / s_{cr,N}$	=	0.71		f_{sy}	=	0.86
d. Influence of edge distance										
$c_{cr,N}$	=	105	mm							
c_x	=	200	mm	$c_x / c_{cr,N}$	=	1.90		$f_{cx,1}$	=	1.00
								$f_{cx,2}$	=	1.00
c_y	=	200	mm	$c_y / c_{cr,N}$	=	1.90		f_{cy}	=	1.00
$N_{Rd,c}$	=	**12.09**	**kN**							
$\beta_{N,c}$	=	62	%							

4. Splitting failure

No verification is required if at least one of the following conditions is fulfilled.

a. The edge distance in all directions is $c \geq 1{,}0\ c_{cr,sp,}$ for single fasteners and $c \geq 1{,}2\ c_{cr,sp,}$ for groups of fasteners and the member depth is $h \geq h_{min}$ in both cases, with h_{min} corresponding to $c_{cr,sp}$.

(applies)

b. The characteristic resistances for concrete cone failure and pull-out failure (headed and post-installed mechanical fasteners) or combined pull-out and concrete failure (bonded fasteners) are calculated for cracked concrete and reinforcement resists the splitting forces and limits the crack width to wk ≈ 0,3 mm.

$$N_{Rd,sp} = N^0_{Rd,sp} \cdot f_{b,N} \cdot f_{hef} \cdot f_{sx,sp} \cdot f_{sy,sp} \cdot f_{cx,1,sp} \cdot f_{cx,2,sp} \cdot f_{cy,sp} \cdot f_h$$

								Verification	
c_x	=		mm	$c_{cr,sp}$	=		mm	$c_x \geq c_{cr,sp}$	Not required
					=		mm	$c_x \geq 1{,}2\ c_{cr,sp}$	Not required
c_y	=		mm	$c_{cr,sp}$	=		mm	$c_y \geq c_{cr,sp}$	Not required
					=		mm	$c_y \geq 1{,}2\ c_{cr,sp}$	Not required
h	=		mm	h_{min}	=		mm	$h \geq h_{min}$	
$N^0_{Rd,sp}$	=		kN						
a. Influence of concrete strength									
$f_{b,N}$	=								
b. Influence of embedment depth									
f_{hef}	=								

c. Influence of spacing										
$s_{cr,sp}$	=		mm							
s_x	=		mm	$s_x / s_{cr,sp}$	=		$f_{sx,sp}$	=		
s_y	=		mm	$s_y / s_{cr,sp}$	=		$f_{sy,sp}$	=		
d. Influence of edge distance										
$c_{cr,sp}$	=		mm							
c_x	=		mm	$c_x / c_{cr,sp}$	=		$f_{cx,1,sp}$	=		
							$f_{cx,2,sp}$	=		
c_y	=		mm	$c_y / c_{cr,sp}$	=		$f_{cy,sp}$	=		
e. Influence of concrete member thickness										
h	=		mm	h_{min}	=		mm	h/h_{min}	=	
f_h	=									
$N_{Rd,sp}$	**=**		kN							
$\beta_{N,sp}$	=									

B. Required verification of post-installed anchor in shear

1. Steel failure, shear load without lever arm

$V^0_{Rd,s}$	=	24	kN	
$\beta_{V,s}$	=	16	%	

2. Concrete pry-out

$V_{Rd,c}$	=	$k \cdot N_{Rd,c}$		
$N_{Rd,c}$	=	12.09		
k	=	2,4		
$V_{Rd,cp}$	**=**	**29.02**	kN	
$\beta_{V,cp}$	=	13	%	

3. Concrete edge breakout

Verification of concrete edge failure may be omitted for single fasteners and groups with an edge distance in all directions $c \geq \max(10\, h_{ef}; 60\, d)$.

For anchorages with more than one edge, the resistance for all edges shall be calculated. The smallest value should be used in the verification.

$V_{Rd,c}$	=	$V^0_{Rd,c} \cdot f_{b,V} \cdot f_{s,V} \cdot f_{c2,V} \cdot f_a \cdot f_h$		
$V^0_{Rk,c}$	=	21.2	kN	

a. Influence of concrete strength			
$f_{b,N}$	=	1.22	

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b. Influence of spacing											
In groups loaded perpendicular to the edge, only two adjacent anchors closest and parallel to the edge carry the load. The same spacing should be used for the verification.											
s	=	150	mm	c_1	=	200	s/c_1	=	0.75	$f_{s,v}$	= 1.25
c. Influence of edge distance											
c_2	=	200	mm	c_1	=	200	c_2/c_1	=	1	$f_{c2,v}$	= 0.75
d. Influence on load direction											
a	=	0	°								
f_a	=	1									
e. Influence on member thickness											
h	=	300	mm	c_1	=	200	h/c_1	=	1.50		
f_h	=	1									
$V_{Rd,c}$	**=**	**24.25**	**kN**	for a single anchor							
$\beta_{V,c}$	=	62	%								