Adhesive (Bonded) Anchors in Accordance with EOTA Technical Report TR 029
Designer should reference the latest TR029 for a complete description of all variables and calculations

1. Tension Resistance

The Design Tension Load, (N_{Sd}), shall be less than the controlling (lowest) Design Resistance, $N_{Rd} = (N_{Rk}/\gamma_M)$, per the following table:

Failure Mode	Single Anchor	Anchor Group	
Steel	$N_{Sd} \leq N_{Rk,s}/\gamma_{Ms}$	$N^h_{Sd} \leq N_{Rk,s}/\gamma_{Ms}$	
Combined Pull-out and Concrete Cone	$N_{Sd} \leq N_{Rk,p}/\gamma_{Mp}$	$N^h_{Sd} \leq N_{Rk,p}/\gamma_{Mp}$	
Concrete Cone	$N_{Sd} \leq N_{Rk,c}/\gamma_{Mc}$		$N^g_{Sd} \leq N_{Rk,c}/\gamma_{Mc}$
Concrete Splitting	$N_{Sd} \leq N_{Rk,sp}/\gamma_{Msp}$		$N^g_{Sd} \leq N_{Rk,sp}/\gamma_{Msp}$

γ_M = the relevant material partial safety factor given in the product's ETA

A. Steel Resistance, $\mathbf{N_{Rk,s}}$ (given in the relevant ETA, or calculated based on the steel insert properties)

B. Combined Pull-out and Concrete Cone Resistance, $\mathbf{N_{Rk,p}}$,determined as follows:

$\mathbf{N_{Rk,p}}$ = $N_{0Rk,p}\,(A_{p,N}/A^0_{p,N})\,\Psi_{s,Np}\,\Psi_{g,Np}\,\Psi_{ec,Np}\,\Psi_{re,Np}$

$N^0_{Rk,p}$ = $\pi\, d\, h_{ef}\, \tau_{Rk}$

$A^0_{p,N}$ = influence area of an individual anchor with large spacing and edge distance at the concrete surface, idealizing the concrete cone as a pyramid with a base length equal to $s_{cr,Np}$

$A_{p,N}$ = actual area; it is limited by overlapping areas of adjoining anchors ($s \leq s_{cr,Np}$) as well as by edges of the concrete member ($c \leq c_{cr,Np}$)

$\Psi_{s,Np}$ - takes account of the disturbance of the distribution of stresses in the concrete due to edges of the concrete member

$\Psi_{g,Np}$ - takes account of the effect of the failure surface for anchor groups

$\Psi_{ec,Np}$ - takes account of a group effect when different tension loads are acting on the individual anchors of a group

$\Psi_{re,Np}$ - takes account of the effect of a reinforcement

C. Concrete Cone Resistance, $\mathbf{N_{Rk,c}}$, determined as follows:

$\mathbf{N_{Rk,c}}$ = $N^0_{Rk,c}\,(A_{c,N}/A^0_{c,N})\,\Psi_{s,N}\,\Psi_{re,N}\,\Psi_{ec,N}$

$N^0_{RK,c}$ = $k_1\,(f_{ck,cube})^{0.5}\,h_{ef}^{1.5}$

k1 = 7.2 for applications in cracked concrete

k1 = 10.1 for applications in non-cracked concrete

$A^0_{c,N}$ = influence area of an individual anchor with large spacing and edge distance at the concrete surface, idealizing the concrete cone as a pyramid with a base length equal to $s_{cr,N}$

$A_{c,N}$ = actual area; it is limited by overlapping areas of adjoining anchors ($s \leq s_{cr,N}$) as well as by edges of the concrete member ($c \leq c_{cr,N}$)

$\Psi_{s,N}$ = $[0.7 + 0.3(c/c_{cr,N})] \leq 1$; takes account of the disturbance of the distribution of stresses in the concrete due to edges of the concrete member

$\Psi_{re,N}$ = $[0.5 + (h_{ef} / 200)] \leq 1$; shell spalling factor takes account of the effect of reinforcement

$\Psi_{ec,N}$ = $[1 / (1 + 2e_N/s_{cr,N})] \leq 1$; takes account of a group effect when different tension loads are acting on the individual anchors of a group, where e_N = eccentricity of the resulting tensile load acting on the tensioned anchors

D. Splitting resistance due to load, $\mathbf{N_{Rk,sp}}$, determined as follows:

$\mathbf{N_{Rk,sp}}$ = $N^0_{Rk,c}\,(A_{c,N}/A^0_{c,N})\,\Psi_{s,N}\,\Psi_{re,N}\,\Psi_{ec,N}\,\Psi_{h,sp}$

where $N^0_{Rk,c}$; $\Psi_{s,N}$; $\Psi_{re,N}$; $\Psi_{ec,N}$ are determined in part C. above

$A^0_{c,N}$ = influence area of an individual anchor with large spacing and edge distance at the concrete surface, idealizing the concrete cone as a pyramid with a base length equal to $s_{cr,sp}$

$A_{c,N}$ = actual area; it is limited by overlapping areas of adjoining anchors ($s \leq s_{cr,sp}$) as well as by edges of the concrete member ($c \leq c_{cr,sp}$)

$\Psi_{h,sp}$ = $(h/h_{min})^{2/3}$; factor to account for the influence of the actual member depth, h, on the splitting resistance for anchors according to current experience

$\mathbf{N_{Rk}}$ is the lesser of: $N_{Rk,s}$; $N_{Rk,p}$; $N_{Rk,c}$; $N_{Rk,sp}$

$\mathbf{N_{Rd}} = N_{Rk}/\gamma_M$

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2. Shear Resistance

The Design Shear Load, (V_{Sd}), shall be less than the controlling (lowest) Design Resistance, $V_{Rd} = (V_{Rk}/\gamma_M)$, per the following table:

Failure Mode	Single Anchor	Anchor Group	
Steel Resistance, shear load without lever arm	$V_{Sd} \le V_{Rk,s}/\gamma_{Ms}$	$V^h_{Sd} \le V_{Rk,s}/\gamma_{Ms}$	
Steel Resistance, shear load with lever arm	$V_{Sd} \le V_{Rk,s}/\gamma_{Ms}$	$V^h_{Sd} \le V_{Rk,s}/\gamma_{Ms}$	
Concrete Pry-out Resistance	$V_{Sd} \le V_{Rk,cp}/\gamma_{Mc}$		$V^g_{Sd} \le V_{Rk,cp}/\gamma_{Mc}$
Concrete Edge Resistance	$V_{Sd} \le V_{Rk,c}/\gamma_{Mc}$		$V^g_{Sd} \le V_{Rk,c}/\gamma_{Mc}$

γ_M = the relevant material partial safety factor given in the product's ETA

A. Steel Resistance, $\mathbf{V_{Rk,s}}$ (given in the relevant ETA, or calculated based on the steel insert properties)

B. Concrete Pry-out Resistance, $\mathbf{V_{Rk,cp}}$, determined as follows:

$\mathbf{V_{Rk,cp}}$ = k multiplied by the lower of $N_{Rk,c}$ and $N_{Rk,p}$
k is taken from the relevant ETA report

C. Characteristic Concrete Edge Resistance, $\mathbf{V_{Rk,c}}$, determined as follows:

$\mathbf{V_{Rk,c}} = V^0_{Rk,c} (A_{c,V}/A^0_{c,V})\ \Psi_{s,V}\ \Psi_{h,V}\ \Psi_{\alpha,V}\ \Psi_{ec,V}\ \Psi_{re,V}$

$V^0_{Rk,c} = k_1\ d_{nom}^{\alpha}\ h_{ef}^{ß}\ (f_{ck,cube})^{0.5} c_1^{1.5}$

k_1 = 1.7 for applications in cracked concrete

k_1 = 2.4 for applications in non-cracked concrete

$\alpha = 0.1\ (l_f / c_1)^{0.5}$

$ß = 0.1\ (d_{nom} / c_1)^{0.2}$

$A^0_{c,V}$ = area of concrete cone of an individual anchor at the lateral concrete surface not affected by edges parallel to the assumed loading direction, member thickness or adjacent anchors, assuming the shape of the fracture area as a half pyramid with a height equal to c_1 and a base-length of 1.5 c_1 and 3 c_1

$A_{c,V}$ = actual area of concrete cone of anchorage at the lateral concrete surface. It is limited by the overlapping concrete cones of adjoining anchors ($s \le 3\ c_1$) as well as by edges parallel to the assumed loading direction ($c_2 \le 1.5\ c_1$) and by member thickness ($h \le 1.5\ c_1$).

$\Psi_{s,V}$ = $[0.7 + (0.3\ c_2 / 1.5\ c_1)] \le 1.0$; takes account of the disturbance of the distribution of stresses in the concrete due to further edges of the concrete member on the shear resistance

$\Psi_{h,V}$ = $[1.5c_1/h]^{1/2} \le 1.0$; takes account of the fact that the shear resistance does not decrease proportionally to the member thickness as assumed by the ratio $A_{c,V}/A^0_{c,V}$

$\Psi_{\alpha,V}$ = $[1 / [(\cos_{\alpha,V})^2 + (\sin_{\alpha,V} / 2.5)^2]] \ge 1.0$; takes account of the angle $\alpha_{,V}$ between the load applied, V_{Sd}, and the direction perpendicular to the free edge of the concrete member

$\Psi_{ec,V}$ = $[1 / (1 + 2e_v / 3c_1)] \le 1.0$; takes account of a group effect when different shear loads are acting on the individual anchors of a group

$\Psi_{re,V}$ = 1.0 anchorage in non-cracked concrete and anchorage in cracked concrete without edge reinforcement or stirrups

$\Psi_{re,V}$ = 1.2 anchorage in cracked concrete with straight edge reinforcement (≥ Ø12 mm)

$\Psi_{re,V}$ = 1.4 anchorage in cracked concrete with edge reinforcement and closely spaced stirrups ($a \le 100$ mm)

> $\mathbf{V_{Rk}}$ is the lesser of $V_{Rk,s}$; $V_{Rk,cp}$; $V_{Rk,c}$
> $\mathbf{V_{Rd}} = V_{Rk}/\gamma_M$

3. Combined Tension & Shear

The following conditions must first be met:

$ßN \le 1$, where $ßN = N_{Sd}/N_{Rd}$

AND

$ßV \le 1$ where $ßV = V_{Sd}/V_{Rd}$

For Combined Tension and Shear Loading:

$ßN + ßV \le 1.2$ (more conservative results)

OR

$(ßN)^{\alpha} + (ßV)^{\alpha} \le 1$ (more accurate results)

α = 2.0 if N_{Rd} and V_{Rd} are governed by steel resistance

α = 1.5 for all other failure modes