



ACI 318 - Anchoring to Concrete

Example of the ACI - Anchoring to Concrete - Post-Installed Anchors. Note: The following information is meant only as a quick reference. The reader should refer to ACI 318-14 Chapter 17 for complete information.

1) Definitions

A_{se} = Effective cross-sectional area of the anchor

f_{ya} = Yield stress of anchor bar

f_{uta} = Shall be taken as 125,000 psi or $1.9*f_{ya}$, whichever is less

h_{ef} = Anchor embedment depth

A_{Nco} = $9*h_{ef}^2$ = Maximum theoretical area of concrete available for breakout capacity at a given embedment depth
Equation 17.4.2.1c

A_{Nc} = See R17.4.2.1, as breakout is dependent on concrete geometry, edge distance and group considerations (see page 15 this manual for additional information)

k_c = 17 for post-installed anchors and 24 for cast-in anchors

f_c = Compressive Strength of Concrete

ψ_c = Modification factor for anchors located in a region of a concrete member where analysis indicates no cracking at service load levels = 1.25 for cast-in anchors and 1.40 for post-installed anchors

ψ_{ec} = Modification factor for anchor groups loaded eccentrically in tension (shall not be taken greater than 1.0)
Equations 17.4.2.4 (tension) and 17.5.2.5 (shear)

ψ_{ed} = Modification factor for edge effects for single anchors or anchor groups loaded in tension
Equations 17.4.2.5a and 17.4.2.5b (tension) and 17.5.2.6a and 17.5.2.6d (shear)

ψ_{cp} = Modification factor for post-installed anchors designed for uncracked concrete, without supplementary reinforcement to control splitting - Equation 17.4.2.7a and 17.4.2.7b

ψ_h = $\sqrt{\frac{(1.5*c_{a1})}{h_a}}$ Modification factor for anchors located in a concrete member where ($h_a < 1.5*c_{a1}$)

A_{Vc} = See R17.5.2.1b, projected area of single and group anchor based on concrete geometry, edge distance and group considerations

c_{a1} = Distance from center of the anchor to open face of concrete

A_{Vco} = $4.5*(c_{a1})^2$ Maximum theoretical area of concrete available for shear breakout at a given embedment depth
Equation R17.5.2.1a

d_a = Anchor diameter

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2) Anchor(s) in Tension

$$N_{sa} = A_{se} * f_{uta}$$

Anchor nominal tensile strength - 17.4.1.2

$$N_{cb} = \frac{A_{Nc}}{A_{Nco}} * \psi_{ed} * \psi_c * \psi_{cp} * N_b$$

Single anchor breakout strength - 17.4.2.1a

$$N_{cbg} = \frac{A_{Nc}}{A_{Nco}} * \psi_{ec} * \psi_{ed} * \psi_c * \psi_{cp} * N_b$$

Anchor group breakout strength - 17.4.2.1b

$$N_b = k_c * \sqrt{f_c} * h_{ef}^{1.5}$$

Basic breakout strength of a single anchor in tension in cracked concrete
17.4.2.2a

3) Anchor(s) in Shear

$$V_{sa} = 0.6 * A_{se} * f_{uta}$$

Anchor nominal shear strength - 17.5.1.2b

$$V_{cb} = \frac{A_{Vc}}{A_{Vco}} * \psi_{ed} * \psi_c * \psi_h * V_b$$

Single anchor shear strength - 17.5.2.1a

$$V_{cbg} = \frac{A_{Vc}}{A_{Vco}} * \psi_{ec} * \psi_{ed} * \psi_c * \psi_h * V_b$$

Group anchor shear strength - 17.5.2.1b

V_b shall be the least of the follow two equations:

$$V_b = \left[7 * \left(\frac{l_e}{d_a} \right)^{0.2} * \sqrt{d_a} \right] * \sqrt{f_c} * c_{a1}^{1.5}$$

Basic breakout strength of a single anchor in shear in cracked concrete
17.5.2.2a

OR

$$V_b = 9 * \sqrt{f_c} * c_{a1}^{1.5}$$

17.5.2.2b

$$l_e = h_{ef}$$

for anchors with constant stiffness over the full length of the embedded section, such as post-installed anchors with a tubular shell from the top of the expansion shell to the top of concrete

$$l_e = 2 * d_a$$

for torque-controlled expansion anchors with annular space between the drill hole wall and anchor rod from the top of the expanded cone and shell

$$(l_e \leq 8 * d_a)$$

in all cases

$$V_{cp} = k_{cp} * N_{cp}$$

$N_{cp} = N_{cb}$ Single Anchor Pryout Strength - 17.5.3.1a

$$V_{cpg} = k_{cpg} * N_{cpg}$$

$N_{cpg} = N_{cbg}$ Group Anchor Pryout Strength - 17.5.3.1b

$$\frac{N_{ua}}{\Phi N_n} + \frac{V_{ua}}{\Phi V_n} \leq 1.2$$

Interaction of tensile and shear forces - 17.6.3