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 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