# Pipinich/Downs
# Underground Propane Tank Ballast Weight, Anchor Pullout Strength

Worst case buoyancy for this 500 gallon propane tank which weighs 949 pounds (empty of product) is that it could develop an **uplifting force of 3224 pounds** when fully submerged in ground water.

This upward lift would be restrained by a concrete ballast weight and a group of 4 anchors. The anchors are forged galvanized eye-bolts ½" in diameter and 10" long. The threaded ends are embedded 9" deep [H] into reinforced concrete and are terminated in square galvanized foundation plate washers 3" x 3" and 3/16" thick. The plates are secured to the eye bolts, top and bottom with galvanized round washers and nuts.
**The eyebolts are forged closed and are rated at 2200 pounds each**.

The anchors are embedded 9" into 14.75" thick reinforced concrete. The anchors are spaced such that there is no loss of efficiency due to spacing. Efficiency loss due to edge spacing 0.638.

Pull out Strength Anchor Calculation: 183,672.26 pounds

**Forged eyebolts will fail before concrete.**

Force lbs = 800 psi x $\pi \times 1.4142 \times H^2 \times 0.638$

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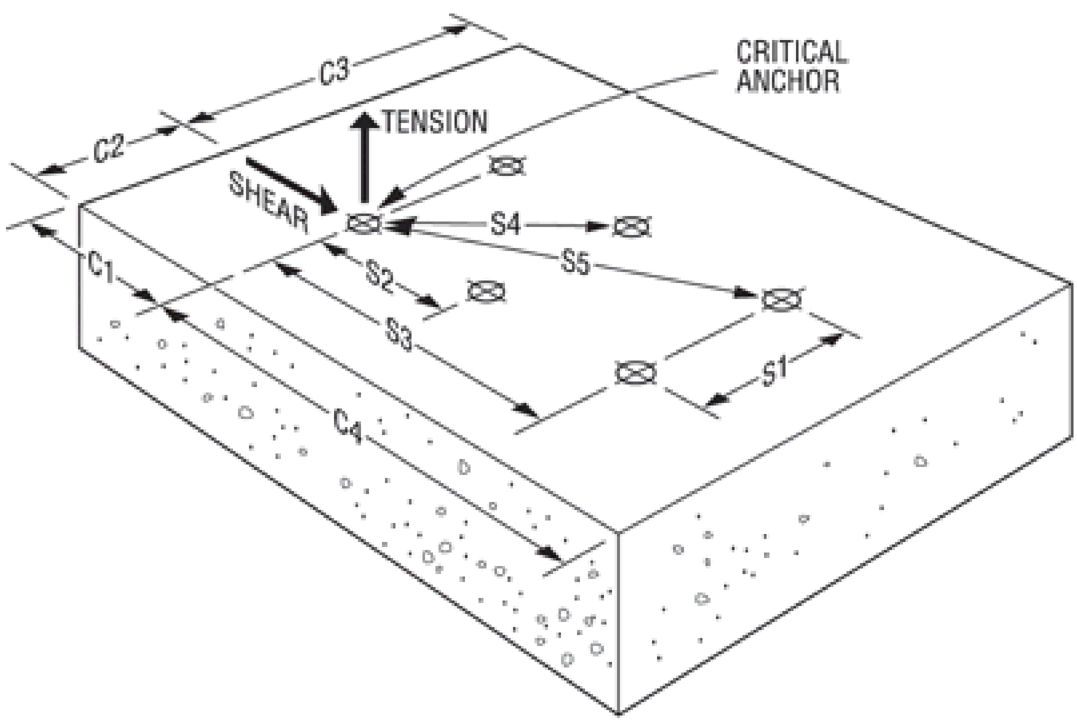
GIVEN:

Base Material Type: Normal Weight Concrete
Base Material Mechanical Properties: f'c = 4000 psi or higher
Base Material Temperature: T = NA
Minimum Base Material Thickness = 14.75 inches
Applied Tension Load per Anchor: Tapplied = 3224 lb.
Applied Shear Load per Anchor: Vapplied = 3224 lb.

Anchor Spacing:
S1 = 37.4 inches
S2 = NA
S3 = 60 inches
S4 = NA
S5 = 70.70 inches

Anchor Edge Distance:
C1 = 33 inches
C2 = 6.9 inches
C3 = 44.3 inches
C4 = 93 inches

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CALCULATIONS:

OPTION 1

Proposed Anchor System = Stainless-Steel Wedge-All
Anchor Diameter (in.) or Rebar Size = 1
Embedment Depth = 9 inches
Temperature Sensitivity Factor: ftemp = 1.00
Short-Term Load Adjustment Factor for Seismic/Wind**: fseismic/wind = Tension: 1.00
Shear: 1.00
**Where permitted by code

Allowable Tension:

T = 6770 lb.

Reduced Efficiency Based on Spacing:

fS1 = 0.70 + [(1 - 0.70)x(37.4 - 4.5)/(12.625 - 4.5)] <= 1, fS1 = 1.000
fS2 = 1 as S2 = NA
fS3 = 0.70 + [(1 - 0.70)x(60 - 4.5)/(12.625 - 4.5)] <= 1, fS3 = 1.000
fS4 = 1 as S4 = NA
fS5 = 0.70 + [(1 - 0.70)x(70.70 - 4.5)/(12.625 - 4.5)] <= 1, fS5 = 1.000
(fS)tot. = 1.000 x 1.000 x 1.000 x 1.000 x 1.000 = 1.000

Reduced Efficiency Based on Edge/End Distance:

fC1 = 0.70 + [(1 - 0.70)x(33 - 4)/(10 - 4)] <= 1, fC1 = 1.000
fC2 = 0.70 + [(1 - 0.70)x(6.9 - 4)/(10 - 4)] <= 1, fC2 = 0.845
fC3 = 0.70 + [(1 - 0.70)x(44.3 - 4)/(10 - 4)] <= 1, fC3 = 1.000
fC4 = 0.70 + [(1 - 0.70)x(93 - 4)/(10 - 4)] <= 1, fC4 = 1.000
(fC)tot. = 1.000 x 0.845 x 1.000 x 1.000 = 0.845

Tdesign is equal to:

Tdesign = 6770 x 1.000 x 0.845 x 1.00 x 1.00 = 5721 lb. >=Tapplied, OK

Allowable Shear:

V = 7295 lb.

Reduced Efficiency Based on Spacing:

fS1 = 0.79 + [(1 - 0.79)x(37.4 - 4.5)/(12.625 - 4.5)]  <= 1,  fS1 =  1.000
fS2 = 1 as S2 = NA
fS3 = 0.79 + [(1 - 0.79)x(60 - 4.5)/(12.625 - 4.5)]  <= 1,  fS3 =  1.000
fS4 = 1 as S4 = NA
fS5 = 0.79 + [(1 - 0.79)x(70.70 - 4.5)/(12.625 - 4.5)]  <= 1,  fS5 =  1.000
(fS)tot. = 1.000 x 1.000 x 1.000 x 1.000 x 1.000 = 1.000

Reduced Efficiency Based on Edge/End Distance:

fC1 = 0.30 + [(1 - 0.30)x(33 - 4)/(10 - 4)]  <= 1,  fC1 =  1.000
fC2 = 0.30 + [(1 - 0.30)x(6.9 - 4)/(10 - 4)]  <= 1,  fC2 =  0.6383
fC3 = 0.30 + [(1 - 0.30)x(44.3 - 4)/(10 - 4)]  <= 1,  fC3 =  1.000
fC4 = 0.30 + [(1 - 0.30)x(93 - 4)/(10 - 4)]  <= 1,  fC4 =  1.000
(fC)tot. = 1.000 x 0.6383 x 1.000 x 1.000 = 0.6383

Allowable Shear Value for Design:

Vdesign is equal to:

Vdesign = 7295 x 1.000 x 0.6383 x 1.00 x 1.00 = 4657 lb. >=Vapplied, OK

Check Combined Tension & Shear Interaction:

(Tapplied/Tdesign)^n + (Vapplied/Vdesign)^n  < or = 1.0

(3224/5721)^1.666667 + (3224/4657)^1.666667 = 0.926357 < or = 1.0 OK

Where n = 5/3 for Carbon/Stainless Steel Wedge-All, Titen HD and Carbon/Stainless Steel Drop-In anchors installed in Normal Weight Concrete only. Otherwise, n = 1 for all other cases.