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File : ClaytonSgns912c.mcd

Site : Chick-Fil-A
US Highway 50 and MO State Route 291
Lee's Summit, Missouri 64081

Project : 9'-0" clearance bar on a caisson footing over two (2) drive thru lanes.
Drawing No. 2510067 rev. A

Design loads are based on the 2018 International Building Code (ASCE 7-16) using Exposure C and 115 mph wind speed.

Design Wind Speed : (mph.) $V := 115.0$ Based on Risk Category II

Velocity Pressure Coefficient at a Height of Less Than 15', Exposure C : $Kz := 0.85$ Based on Table 26.10-1

Topographic Factor : $Kzt := 1.00$ Based on Table 26.8-1

Wind Directionality Factor : $Kd := 0.85$ Based on Table 26.6-1

Velocity Pressure : (PSF) $qz := 0.00256 \cdot Kz \cdot Kzt \cdot Kd \cdot V^2$ $qz = 24.461$ Based on Equation 26.10-1

Force Coefficient : $Cf := 2.0$ Based on Figure 29.4-2

Gust Effect Factor : $G := 0.85$ Based on 26.11.4 for Other Structures

ASD Conversion Factor : $LCF := 0.60$

Design Pressure : (PSF) $F := qz \cdot Cf \cdot G \cdot LCF$ $F = 24.95$

Design Snow Load : (PSF) $SL := 25.0$ Based on Ground Snow Loads.

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Reference : Manual of Steel Construction, AISC 15th Edition.

Tube : ASTM A-500 Gr. B Fy = 46.0 ksi. ; Fb = 30.36 ksi. ; Fv = 18.40 ksi.

Round Mechanical Tube : ASTM A-513 Gr. 5 Fy = 35.0 ksi. ; Fb = 23.10 ksi. ; Fv = 14.00 ksi.

Plate : ASTM A-36 Fy = 36.0 ksi. ; Fb = 27.00 ksi. ; Fv = 14.40 ksi.

Anchor Bolts : ASTM F-1554 Gr. 36 Fu = 58.0 ksi. ; Ft = 19.14 ksi. ; Fv = 14.40 ksi.

Reference : 2020 Aluminum Design Manual, The Aluminum Association

Tube: 6061-T6 Temper and Alloy Fy = 35.0 ksi. ; Fb = 21.21 ksi. ; Fv = 12.72 ksi. ;
within 1" of welds Fyw = 15 ksi. ; Fbw = 9.09 ksi. ; Fvw = 5.45 ksi.

Plate : 5052-H34 Temper and Alloy Fy = 26.0 ksi. ; Fb = 14.2 ksi. ; Fv = 9.5 ksi. ;
within 1" of welds Fyw = 9.5 ksi. ; Fbw = 8.6 ksi. ; Fvw = 3.5 ksi.

Reference : American Concrete Institute, Code 318.14

Rebar : ASTM A-615 Grade 60 Fy = 60.0 ksi.

Concrete : 3,000 psi. compressive strength at 28 days.

Design Loads at EL 9.0' :

Offset Wind Load :

Shear : (lbs.) $ShrOSWL := \left(12.5 \cdot \left(\frac{3}{12}\right) \cdot F\right)$ $ShrOSWL = 77.969$

Moment : (ft.lbs.) $MtOSWL := ShrOSWL \cdot \left(\frac{12.5}{2}\right)$ $MtOSWL = 487.308$

Offset Dead Load :

Shear : (lbs.) $ShrOSDL := (12.5 \cdot 3.30)$ $ShrOSDL = 41.25$

Moment : (ft.lbs.) $MtOSDL := ShrOSDL \cdot \left(\frac{12.5}{2}\right)$ $MtOSDL = 257.813$

Offset Snow Load :

Shear : (lbs.) $ShrOSSL := \left(12.5 \cdot \left(\frac{3}{12}\right) \cdot SL\right)$ $ShrOSSL = 78.125$

Moment : (ft.lbs.) $MtOSSL := ShrOSSL \cdot \left(\frac{12.5}{2}\right)$ $MtOSSL = 488.281$

Combined Moment :

Summation : (ft.lbs.) $MtEL9_0 := MtOSWL + MtOSDL + MtOSSL$ $MtEL9_0 = 1233.402$

Combined Shear :

Summation : (ft.lbs.) $ShrEL9_0 := ShrOSWL + ShrOSDL + ShrOSSL$ $ShrEL9_0 = 197.344$

Design of Clearance Arm :

Section Modulus of Tube : (in.3) 3" x 3" x 1/4" wall - $TubeSM := 2.33$

Bending Stress : (psi.) $f_b := \frac{MtEL9_0 \cdot 12}{TubeSM}$ $f_b = 6352.285$

Area of Tube : (in.2) 3" x 3" x 1/4" wall - $TubeArea := 2.75$

Bending Stress : (psi.) $f_v := \frac{ShrEL9_0}{TubeArea}$ $f_v = 71.762$

Unity Check : Clearance Arm $UCClrncArm := \frac{f_b}{9090} + \frac{f_v}{5450}$ $UCClrncArm = 0.712$ < 1.00 OK

Design of Insert Pipe at EL. 9.0' :

Round Mechanical Tube : 5-5/8" Dia. x 0.312" wall - (6061-T6)

Dia : (in.) $Dia := 5.625$

Radius : (in.) $r := \frac{Dia}{2}$ $r = 2.813$

Area : (in.2) $A := 5.21$

Section Modulus : (in.3) $SM := 6.55$

Torsional Stiffness Constant : (in.4) $J := 28.5$

Bending Stress : (psi.) $f_b := \frac{MtEL9_0 \cdot 12}{SM}$ $f_b = 2259.668$

Shear Stress : (psi.) $fv := \frac{ShrEL9_0}{A}$ $fv = 37.878$

Torsional Stress : (psi.) $ft := \frac{(MtOSWL \cdot 12) \cdot r}{J}$ $ft = 577.075$

Combined Shear Stress : (psi.) $fv_{Comb} := \sqrt{\left((fv + ft)^2 + ft^2\right)}$ $fv_{Comb} = 843.317$

Unity Check : Insert Pipe $UCInsertPipe := \frac{f_b}{9090} + \frac{fv_{Comb}}{5450}$ $UCInsertPipe = 0.403$ < 1.00 OK

Design Loads at Grade :

Wind Load :

Arm : $Arm := \left(13.0 \cdot \left(\frac{3}{12}\right) \cdot F\right) \cdot \left(\left(\frac{0.25}{2}\right) + 9.0\right)$ $Arm = 739.929$ ft.lbs.

Pole : $Pole := \left(9.0 \cdot \left(\frac{6}{12}\right) \cdot F\right) \cdot \left(\frac{9.0}{2}\right)$ $Pole = 505.241$ ft.lbs.

Moment : (ft.lbs.) $MtWL := Arm + Pole$ $MtWL = 1245.17$

Shear : (lbs.) $ShrWL := \left(13.0 \cdot \left(\frac{3}{12}\right) \cdot F\right) + \left(9.0 \cdot \left(\frac{6}{12}\right) \cdot F\right)$ $ShrWL = 193.364$

Combined Moment :

Summation : (ft.lbs.) $MtGrd := MtWL + MtOSDL + MtOSSL$ $MtGrd = 1991.264$

Combined Shear :

Summation : (lbs.) $ShrGrd := ShrWL + ShrOSDL + ShrOSSL$ $ShrGrd = 312.739$

Design of Pole at Grade :

Tube : HSS 6" x 6" x 1/8" wall - Area : (in.2) $A := 2.70$

Section Modulus : (in.3) $SM := 5.15$

Torsional Stiffness Constant : (in.4) $C := 8.03$

Bending Stress : (psi.) $f_b := \frac{MtGrd \cdot 12}{TubeSM}$ $f_b = 10255.435$

Shear Stress : (psi.) $fv := \frac{ShrGrd}{A}$ $fv = 115.829$

Torsional Stress : (psi.) $ft := \frac{(MtOSWL \cdot 12)}{C}$ $ft = 728.231$

Combined Shear Stress : (psi.) $fv_{Comb} := \sqrt{\left((fv + ft)^2 + ft^2\right)}$ $fv_{Comb} = 1114.791$

Unity Check - Pole : $UCPole := \frac{f_b}{30360} + \frac{fv_{Comb}}{18400}$ $UCPole = 0.398$ < 1.00 OK

Design of Anchor Bolts at Grade :

Anchor Bolt Diameter : (in.) $AncBltDia := 1.00$

Stress Area : (in.2) $AncBltArea := \frac{\pi \cdot AncBltDia^2}{4}$ $AncBltArea = 0.785$
(Based on nominal diameter per AISC 4-3)

Allowable Tension : (lbs.) $AllwTen := 19140 \cdot AncBltArea$ $AllwTen = 15033$

Allowable Shear : (lbs.) $AllwShr := 14400 \cdot AncBltArea$ $AllwShr = 11310$

Number of Anchor Bolts in Tension : $NoTen := 2$

Front to Back Distance Between Anchor Bolts : (in.) $LvrArm := 8.0$

Tension Load per Anchor Bolt : (lbs.) $TenAncBlt := \frac{MtGrd \cdot 12}{NoTen \cdot LvrArm}$ $TenAncBlt = 1493.45$

Number of Anchor Bolts in Shear : $NoShr := 4$

Number of Bolt Couples : $NoBltCpls := 2$

Side to Side Distance Between Anchor Bolts : (in.) $BltSprd := 8.0$

Diagonal Distance Between Anchor Bolts : (in.) $BltDiagnl := \sqrt{\left(LvrArm^2 + BltSprd^2\right)}$

$BltDiagnl = 11.314$

Shear Load per Anchor Bolt : (lbs.) $ShrAncBlt := \frac{ShrGrd}{NoShr} + \frac{(MtOSWL \cdot 12)}{NoBltCpls \cdot BltDiagnl}$

$ShrAncBlt = 336.62$

Unity Check : $UCAncBlts := \frac{TenAncBlt}{AllwTen} + \frac{ShrAncBlt}{AllwShr}$ $UCAncBlts = 0.129$ < 1.00 OK
Anchor Bolts

Allowable Bond Stress : (lbs./ in.2) $U := \left(\frac{1}{2}\right) \cdot \left(\frac{4.8 \cdot \sqrt{3000}}{AncBltDia}\right)$ $U = 131.453$

Development Length : (in.) $Ld := \frac{TenAncBlt}{U \cdot \pi \cdot AncBltDia}$ $Ld = 3.616$

Embedment Length : (in.) $AncBltEmb := 36 - 6$ $AncBltEmb = 30$
(36" overall length minus 6" of thread projection.)

Unity Check : Anchor Bolt Embedment $UCABEmb := \frac{Ld}{AncBltEmb}$ $UCABEmb = 0.121$ < 1.00 OK

Use : Four (4) 1" Dia. x 36" anchor bolts with 6" of top thread and 3" bottom thread.

Design of Base Plate at Grade :

Plate Thickness : (in.) $PltThk := 0.75$ Plate Width : (in.) $PltWdth := 13.0$

Transfer Distance : (in.) $PLS := \frac{BltDiagnl - \sqrt{\left(6.0^2 + 6.0^2\right)}}{2}$ $PLS = 1.414$

Minimum Thickness Required : (in.) $ReqdThk := \sqrt{\left(\frac{TenAncBlt \cdot NoTen \cdot PLS \cdot 6}{(PltWdth \cdot 27000)}\right)}$ $ReqdThk = 0.269$

Unity Check - Base Plate : $UCBasePlt := \frac{ReqdThk}{PltThk}$ $UCBasePlt = 0.358$ < 1.00 OK

Use : 3/4" thick x 13" x 13" base plates with four (4) 1-1/4" diameter holes on a 8" square bolt pattern.

Design of Caisson Footing :

Overturning Moment : (ft.lbs.)	$Ma := MtGrd$	$Ma = 1991.264$
Shear : (lbs.)	$Va := ShrGrd$	$Va = 312.739$
Applied Lateral Force : (lbs.)	$P := Va$	$P = 312.739$
Allowable Lateral Soil Pressure : (lbs./ft.2 per ft.)		$LP := 150$
Diameter of Round Footing : (ft.)		$b1 := 2.0$
Distance in Feet From Ground Surface to Point of Application of "P"	$h := \frac{Ma}{Va}$	$h = 6.367$
Depth of Footing Below Grade : (ft.)		$d1 := 3.5$
Allowable Lateral Soil Bearing Pressure Pursuant to Section 1807.3.2.1 and Table 1806.2 with 100% increase for allowable 1/2" deflection at grade.	$S1 := \frac{d1}{3} \cdot (2 \cdot LP)$	$S1 = 350$

$A := 2.34 \cdot \frac{P}{S1 \cdot b1}$ $A = 1.045$

$d2 := \left(\frac{A}{2}\right) \cdot \left(1 + \left(\sqrt{1 + 4.36 \cdot \frac{h}{A}}\right)\right)$ $d2 = 3.267$ $\leq$ $d1 = 3.5$ OK

Check Tensile Stress in Footing :

Overturning Moment About Heel Point : (ft.lbs.) Treat as a cantilever at bottom.	$Mh := Ma + (Va \cdot d1)$	$Mh = 3085.85$
Compressive Strength of Concrete : (psi.)		$fc := 3000$
Yield Strength of Rebar : (psi.)		$fy := 60000$

Section Modulus of Footing : (in.3) $Sw := \frac{\pi \cdot (b1 \cdot 12)^3}{32}$ $Sw = 1357.168$

Tensile Stress in Concrete : (psi.) $ft := \left(\frac{1.6 \cdot (Mh \cdot 12)}{Sw}\right)$ $ft = 43.656$

Allowable Concrete Stress : (psi.) $\phi Ft := 0.60 \cdot \left(3 \cdot \sqrt{fc}\right)$ $\phi Ft = 98.59$ $>$ $ft = 43.656$

REBAR NOT REQUIRED FOR STRESS

<u>Design of Shrinkage and Temperature Steel in Caisson :</u>

Rebar Size : $Number := 5$

Rebar Area : (in.2) $Area := \frac{\pi \cdot \left(\frac{Number}{8}\right)^2}{4}$ $Area = 0.31$

Area of Footing : (in.2) $A_f := \frac{\pi \cdot (b1 \cdot 12)^2}{4}$ $A_f = 452.389$

Minimum Area of Steel : (in. 2) $As_{min} := 0.0025 \cdot A_f$ $As_{min} = 1.131$

Number of vertical bars required : $\left(\frac{As_{min}}{Area}\right) = 3.686$

Use (4) #5 Rebar x 3'-0" LG. equally spaced on a 17" circle with (9) #3 rebar ties, top (3) in first 5", (5) on 5" centers, remaining (1) on 9" centers.

<u>Quantity of Concrete</u> : (yds.3) $CY := \frac{\pi \cdot b1^2 \cdot d1}{4 \cdot 27}$ $CY = 0.407$