ROBERT-JAMES & ASSOCIATES, Inc.
12255 West 187th Street
Mokena, Illinois 60448
(708) 479-8385

File : ClaytonSgns912a.mcd

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

Sign Type : 12'-0" overall height direct bury single pole for a 10'-6" x 6'-8" combination ID / manual readerboard sign with 'Closed Sunday' copy and 1'-6" tall x 7'-0" masonry base with both caisson and spade footing options. Drawing No. 2510065 rev. A

Design wind load is 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

For Figure 29.4-1

Overall Height : (ft.) $h := 12.0$ Overall Width : (ft.) $B := 6.67$

Where 's' equals 'h' $s := 12.0$

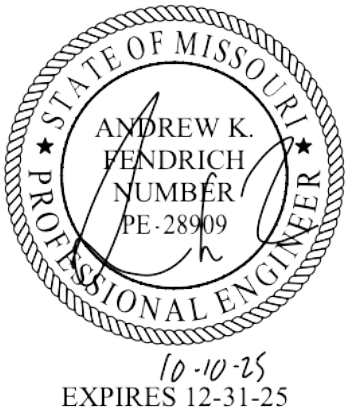
$\frac{s}{h} = 1$ $\frac{B}{s} = 0.556$

Force Coefficient : $Cf := 1.54$ Based on Figure 29.4-1

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

ASD Conversion Factor : $LCF := 0.60$

Design Pressure : (PSF) $F := qz \cdot Cf \cdot G \cdot LCF$ $F = 19.212$



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

Pipe : ASTM A-252 Gr. 3 Fy = 42.0 ksi. ; Fb = 27.72 ksi. ; Fv = 16.80 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 Grade :

Shear : (lbs.) $ShrGrd := (12.0 \cdot 7.0 \cdot F)$ $ShrGrd = 1613.778$

Moment : (ft.lbs.) $MtGrd := ShrGrd \cdot \left(\left(\frac{12.0}{2} \right) + (0.05 \cdot 12.0) \right)$ $MtGrd = 10650.932$

Design of Pole Structure at Grade :

Section Modulus of Pipe : (in.3) 6-5/8" Dia. x 0.280" wall - (6" Sch. 40) $PipeSM := 7.99$

Bending Stress : (psi.) $f_b := \frac{MtGrd \cdot 12}{PipeSM}$ $f_b = 15996.394$

Area of Pipe : (in.2) 6-5/8" Dia. x 0.280" wall - (6" Sch. 40) $PipeArea := 5.22$

Shear Stress : (psi.) $f_v := \frac{ShrGrd}{PipeArea}$ $f_v = 309.153$

Unity Check - Pole : $UCPole := \frac{f_b}{27720} + \frac{f_v}{16800}$ $UCPole = 0.595$ $<$ 1.00 OK

Design of Caisson Footing :

Overturning Moment : (ft.lbs.)	$Ma := MtGrd$	$Ma = 10650.932$
Shear : (lbs.)	$Va := ShrGrd$	$Va = 1613.778$
Applied Lateral Force : (lbs.)	$P := Va$	$P = 1613.778$
Allowable Lateral Soil Pressure : (lbs./ft.2 per ft.)		$LP := 150$
Diameter of Round Footing : (ft.)		$b1 := 3.0$
Distance in Feet From Ground Surface to Point of Application of "P"	$h := \frac{Ma}{Va}$	$h = 6.6$
Depth of Footing Below Grade : (ft.)		$d1 := 4.75$
Allowable Lateral Soil Bearing Pressure Pursuant to Section 1805.7.2.2 and Table 1804.2.	$S3 := (LP \cdot d1)$	$S3 = 712.5$

Required Depth : (ft.) $d2 := \sqrt{4.12 \cdot \left(\frac{P \cdot h}{S3 \cdot b1}\right)}$ $d2 = 4.531$ $\leq$ $d1 = 4.75$ OK

Note : Rebar not required for direct bury pole per Section 1807.3.3.

Slab Parameters :

Depth of slab below grade : (ft.)	$DF := 0.67$
Width of slab : (ft.)	$WF := 8.0$
Length of slab : (ft.) (Wind direction)	$LF := 3.0$

Design of Reinforcing Steel in Slab :

Rebar size : $Number := 4$

Rebar Area : (in.2) $Area := \frac{\pi \cdot \left(\frac{Number}{8}\right)^2}{4}$ $Area = 0.2$

For length of footing : $Asl := 0.0018 \cdot DF \cdot WF \cdot 144$ $Asl = 1.389$

Number required : $\frac{Asl}{Area} = 7.076$ Use eight (8) #4 Rebar x 2'-6" LG. equally spaced using 3" typical side clear thru center of slab.

For width of footing : $Asw := 0.0018 \cdot DF \cdot LF \cdot 144$ $Asw = 0.521$

Number required : $\frac{Asw}{Area} = 2.653$ Use four (4) #4 Rebar x 7'-6" LG. equally spaced using 3" typical side clear thru center of slab.

Quantity of Concrete : (yds.3) $CY := \left(\frac{\left(\pi \cdot (d1 - DF) \cdot b1^2\right)}{4 \cdot 27}\right) + \left(\frac{(LF \cdot WF \cdot DF)}{27}\right)$ $CY = 1.664$

Note : Keep bottom of pipe 3" from bottom of footing to create concrete cover for water exclusion.

Design of Spade Footing :

Allowables :

Lateral passive pressure against foundation : (lbs./sq.ft. per foot) $PP := 150$

Static soil pressure : (lbs./sq.ft.) $SSP := 2000$

Dynamic soil pressure : (lbs./sq.ft.) $DSP := 2000$

Foundation parameters :

Depth of footing below grade : (ft.) $DF := 3.5$

Width of footing : (ft.) $WF := 8.0$

Length of footing : (ft.)
(Wind direction) $LF := 3.0$

Weight of structure and foundation :

Design weight of concrete : (lbs./cu.ft.) $CWT := 150$

Sign and structure weight : (lbs.) $SWT := 675$

Masonry weight : (lbs.) $PWT := 750$

Footing weight : (lbs.) $FTWT := DF \cdot WF \cdot LF \cdot CWT$ $FTWT = 12600$

Net weight : (lbs.) $NETWT := SWT + PWT + FTWT$ $NETWT = 14025$

Check Factor of Safety :

Overturning moment about heel point of foundation : (ft.lbs.)

$$Mo := Va \cdot DF + Ma \qquad Mo = 16299.154$$

Total passive pressure on footing : (lbs./sq.ft.)

$$Tpp := PP \cdot DF^2 \cdot \left(\frac{WF}{2}\right) \qquad Tpp = 7350$$

Resisting moment about the heel point : (ft.lbs.)

$$Mr := NETWT \cdot \left(\frac{LF}{2}\right) + Tpp \cdot \left(\frac{DF}{3}\right) \qquad Mr = 29612.5$$

Factor of Safety : $FS := \frac{Mr}{Mo}$ $FS = 1.817 > 1.5$ OK

Check soil bearing pressures :

Static soil pressure : (lbs./sq.ft.) $SBP := \frac{NETWT}{LF \cdot WF}$ $SBP = 584.375 < SSP = 2000$ OK

Dynamic soil pressure : (lbs./sq.ft.)

$$e := \frac{\left(Mo - Tpp \cdot \left(\frac{DF}{3}\right)\right)}{NETWT} \qquad e = 0.551$$

$$\left(\frac{LF}{2}\right) = 1.5 > e = 0.551 > \left(\frac{LF}{6}\right) = 0.5$$

$$qa := \left(\frac{2 \cdot NETWT}{3 \cdot WF \cdot \left(\left(\frac{LF}{2}\right) - e\right)}\right) \qquad qa = 1231.225 < DSP = 2000 \quad \text{OK}$$

Check tensile stress of concrete at pole :

Compressive Strength of Concrete : (psi.) $fc := 3000$

Overturning moment at pole : (ft.lbs./ft.) $Mp := \left(\frac{LF}{2} \cdot qa\right) \cdot \frac{LF}{4}$ $Mp = 1385.128$

Section modulus of footing - Per foot of width : (in.3)

$$Sw := 12 \cdot \frac{(DF \cdot 12)^2}{6} \qquad Sw = 3528$$

Tensile stress in concrete : (psi.) $ft := \frac{1.6 \cdot (Mp \cdot 12)}{Sw}$ $ft = 7.538$

Allowable stress in concrete : (psi.) $\phi Ft := 0.60 \cdot \left(5 \cdot \sqrt{fc}\right)$ $\phi Ft = 164.317 > ft = 7.538$

REBAR NOT REQUIRED FOR STRESS

Design of temperature and shrinkage steel in footing :

Rebar size : $Number := 6$

Rebar Area : (in.2) $Area := \frac{\pi \cdot \left(\frac{Number}{8}\right)^2}{4}$ $Area = 0.44$

For length of footing : $Asl := \frac{0.0018}{2} \cdot DF \cdot WF \cdot 144$ $Asl = 3.629$

Number required : $\frac{Asl}{Area} = 8.214$ Use ten (10) #6 Rebar x 2'-6" LG. equally spaced top and bottom using 3" typical clear. (Twenty (20) total required.)

For width of footing : $Asw := \frac{0.0018}{2} \cdot DF \cdot LF \cdot 144$ $Asw = 1.361$

Number required : $\frac{Asw}{Area} = 3.08$ Use four (4) #6 Rebar x 7'-6" LG. equally spaced top and bottom using 3" typical clear. (Eight (8) total required.)

Quantity of concrete : (yds.3) $Cy := \left(\frac{(LF \cdot WF \cdot DF)}{27}\right) - \left(\frac{\pi \cdot 0.55^2 \cdot DF}{4 \cdot 27}\right)$

$Cy = 3.08$

Note : Use a 1" thick x 12" square concrete paver at the bottom of the footing, to rest the pole on, for water exclusion.

Compressive Strength of Concrete : (psi.) $fc := 3000$

Overturning moment at pole : (ft.lbs./ft.) $Mp := \left(\frac{LF}{2}\right)^2 \cdot \left(\frac{qa}{2}\right)$ $Mp = 1385.128$

Section modulus of footing - Per foot of width : (in.3)

$$Sw := 12 \cdot \frac{(DF \cdot 12)^2}{6} \qquad Sw = 3528$$

Tensile stress in concrete : (psi.) $ft := \frac{(Mp \cdot 12)}{Sw}$ $ft = 4.711$

Allowable stress in concrete : (psi.) $\phi Ft := 0.65 \cdot \left(5 \cdot \sqrt{fc}\right)$ $\phi Ft = 178.01$ $>$ $ft = 4.711$

REBAR NOT REQUIRED FOR STRESS

Design of temperature and shrinkage steel :

Rebar size : $Number := 3$

Rebar Area : (in.2) $Area := \frac{\pi \cdot \left(\frac{Number}{8}\right)^2}{4}$ $Area = 0.11$

For length of footing : $Asl := 0.00032 \cdot DF \cdot WF \cdot 144$ $Asl = 1.29$

Number required : $\frac{Asl}{Area} = 11.682$ Use six (6) #3 Rebar x 2'-6" LG. equally spaced top and bottom using 3" typical clear. (Twelve (12) total required.)

For width of footing : $Asw := 0.00032 \cdot DF \cdot LF \cdot 144$ $Asw = 0.484$

Number required : $\frac{Asw}{Area} = 4.381$ Use four (4) #3 Rebar x 7'-6" LG. equally spaced top and bottom using 3" typical clear. (Eight (8) total required.)

Quantity of concrete : (yds.3) $Cy := \left(\frac{(LF \cdot WF \cdot DF)}{27}\right)$ $Cy = 3.111$

Note : Use a 1" thick x 12" square concrete paver at the bottom of the footing, to rest the pole on, for water exclusion.