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File : ClaytonSgns912d.mcd

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

Model : EC25 25'-0" one piece flag pole for a 4' x 6' flag with block footing.
Drawing No. 2510068 rev. A

Design wind load is based on 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 25', Exposure C : $Kz := 0.94$ 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) $qz := 0.00256 \cdot Kz \cdot Kzt \cdot Kd \cdot V^2$ $qz = 27.051$ Based on Equation 26.10-1

For Figure 29.5.1

Overall Height : (ft.) $h := 25.0$ Average Diameter of Pole : (ft.) $D := 0.44$

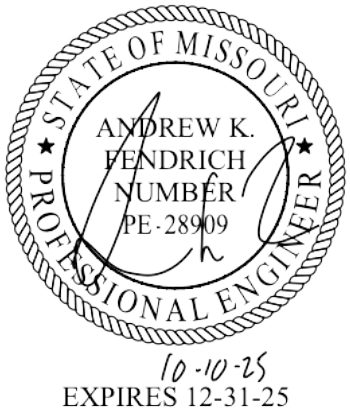
$\frac{h}{D} = 56.818$ $D \cdot \sqrt{qz} = 2.288$

Force Coefficient : $Cf := 1.2$ Based on Figure 29.5.1

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

ASD Conversion Factor : $LCF := 0.60$

Design Pressure : (PSF) $F := qz \cdot Cf \cdot G \cdot LCF$ $F = 16.555$



Reference : 2020 Aluminum Design Manual, The Aluminum Association

Pipe : 6063-T6 Temper and Alloy Fy = 35.0 ksi. ; Fv = 11.33 ksi. ; Fb = 24.00 ksi. (Per 6.8.2 for non-welded members.)

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.

Wind Load on Flag :

Size of Flag : (ft.) Height : $HtFlg := 4$ Width : $WdthFlg := 6$

Flag Load : $WLFlag := \left(0.0014 \cdot V^2\right) \cdot \sqrt{\left(HtFlg \cdot WdthFlg\right)}$ $WLFlag = 90.705$ lbs.

Design Loads at Grade :

Height of Pole : (ft.) $HtPole := 25$

Flag : $Flag := \left(\frac{WLFlag}{2}\right) \cdot (HtPole) + \left(\frac{WLFlag}{2}\right) \cdot (HtPole - WdthFlg)$ $Flag = 1995.501$ ft.lbs.

Tapered Section of Pole : (Including truck.) $TprdP := \left(12.0 \cdot \left(\frac{3.5 + 6.0}{2 \cdot 12}\right) \cdot F\right) \cdot \left(\left(\frac{12.0}{2}\right) + 13.0\right)$ $TprdP = 1494.105$ ft.lbs.

Straight Section of Pole : $StrtP := \left(15.0 \cdot \left(\frac{6.0}{12}\right) \cdot F\right) \cdot \left(\frac{15.0}{2}\right)$ $StrtP = 931.229$ ft.lbs.

Moment : (ft.lbs.) $MtGrd := Flag + TprdP + StrtP$ $MtGrd = 4420.835$

Shear : (lbs.) $ShrGrd := (WLFlag) + \left(12.0 \cdot \left(\frac{3.0 + 6.0}{2 \cdot 12}\right) \cdot F\right) + \left(13.0 \cdot \left(\frac{6.0}{12}\right) \cdot F\right)$ $ShrGrd = 272.812$

Design of Pole Structure at Grade :

Section Modulus of Pole : (in.3) 6" Dia. x 3/16" wall - $OD := 6.0$ $WT := 0.188$

$$PoleSM := \frac{\pi \cdot \left(OD^4 - (OD - 2 \cdot WT)^4\right)}{32 \cdot OD} \qquad PoleSM = 4.836$$

Bending Stress : (psi.) $f_b := \frac{MtGrd \cdot 12}{PoleSM}$ $f_b = 10968.773$

Area of Pole : (in.2) 6" Dia. x 3/16" wall - $PoleArea := \frac{\left\langle \pi \cdot \left\langle OD^2 - (OD - (2 \cdot WT))^2 \right\rangle \right\rangle}{4}$

$PoleArea = 3.433$

Shear Stress : (psi.) $f_v := \frac{ShrGrd}{PoleArea}$ $f_v = 79.475$

Unity Check - Pole : $UCPole := \frac{f_b}{24000} + \frac{f_v}{11330}$ $UCPole = 0.464$ < 1.00 OK

Design of Block Footing :

Overturning Moment : (ft.lbs.)	$Ma := MtGrd$	$Ma = 4420.835$
Shear : (lbs.)	$Va := ShrGrd$	$Va = 272.812$
Applied Lateral Force : (lbs.)	$P := Va$	$P = 272.812$
Allowable Lateral Soil Pressure : (lbs./ft.2 per ft.)		$LP := 150$
Size of Square Footing : (ft.)		$Sq := 3.0$
Diagonal Dimension of Square Footing : (ft.)	$b1 := \sqrt{\langle Sq^2 \cdot 2 \rangle}$	$b1 = 4.243$
Distance in Feet From Ground Surface to Point of Application of "P"	$h := \frac{Ma}{Va}$	$h = 16.205$

Depth of Footing Below Grade : (ft.) $d1 := 4.0$

Allowable Lateral Soil Bearing Pressure Pursuant to Section 1807.3.2.1 and Table 1806.2. $S1 := d1 \cdot \frac{(LP \cdot 1.33)}{3}$ $S1 = 266$

$$A := 2.34 \cdot \frac{P}{S1 \cdot b1} \qquad A = 0.566$$

$$d2 := \left(\frac{A}{2}\right) \cdot \left(1 + \left(\sqrt{1 + 4.36 \cdot \frac{h}{A}}\right)\right) \qquad d2 = 3.456 \quad \leq \quad d1 = 4 \qquad \text{OK}$$

Check Tensile Stress in Footing :

Overturning Moment About Heel Point : (ft.lbs.) Treat as a cantilever at bottom. $Mh := Ma + (Va \cdot d1)$ $Mh = 5512.081$

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

Yield Strength of Rebar : (psi.) $fy := 60000$

Section Modulus of Footing : (in.3) $Sw := \frac{(d1 \cdot 12)^3}{6}$ $Sw = 18432$

Tensile Stress in Concrete : (psi.) $ft := \left(\frac{1.6 \cdot (Mh \cdot 12)}{Sw}\right)$ $ft = 5.742$

Allowable Concrete Stress : (psi.) $\phi Ft := 0.60 \cdot (3 \cdot \sqrt{fc})$ $\phi Ft = 98.59 \quad > \quad ft = 5.742$

REBAR NOT REQUIRED FOR STRESS

Quantity of Concrete : (yds.3) $CY := \left(\frac{d1 \cdot Sq^2}{27}\right) - \left(\frac{\pi \cdot 0.92^2 \cdot 3.0}{4 \cdot 27}\right)$ $CY = 1.259$