

Hand Calculation

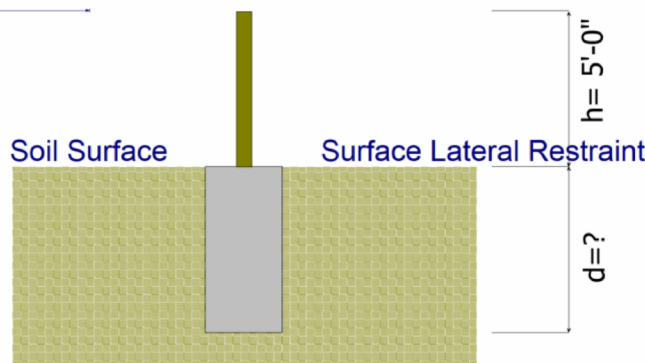
Problem Statement:

Determine minimum footing embedment, d , with given information below

Circular Footing Diameter	$b := 2.5 \text{ ft}$
Lateral Point Load 0.6 W	$P := 1800 \text{ lbf}$
Lateral Load Height Above Footing	$h := 5 \text{ ft}$
Allowable Lateral Passive Pressure	$pp := 100 \frac{\text{psf}}{\text{ft}}$

Top of Footing is constrained per IBC 2021 - 1807.3.2.2

Point Load



Solution:

Step 1: Start by assuming a depth, then check the assumed depth against the calculated depth

For constrained footing, $S3$ is calculated for the full depth of footing.

Trial #a, Assume $d_a = 8\text{ft}$

$$d_a := 8 \text{ ft}$$

$$S3a := pp \cdot d_a$$

$$S3a = 800 \text{ psf}$$

Calculate minimum depth, d (ft) based on the assumed d_a

$$d := \sqrt[2]{\left(\frac{4.25 \cdot P \cdot h}{S3a \cdot b}\right)} = 4.373 \text{ ft}$$

$$d = 4.373 \text{ ft} < d_a = 8 \text{ ft}$$

Calculated depth of 4.373 ft is smaller than the assumed embed depth of 8ft. The value can be used and it produces a safe design. However, to calculate the minimum embedment, we need to re-iterate with a smaller assumed embed depth, d_b .

Step 2: Re-iterate with assuming d value smaller than da from step 1

Trial #b, Assume db = 4.373 ft

$$db := 4.373 \text{ ft}$$

$$S3b := pp \cdot db$$

$$S3b = 437.3 \text{ psf}$$

Calculate minimum depth, d (ft) based on the assumed db

$$d := \sqrt[2]{\left(\frac{4.25 \cdot P \cdot h}{S3b \cdot b}\right)} = 5.915 \text{ ft}$$

$$d = 5.915 \text{ ft} > db = 4.373 \text{ ft}$$

Calculated depth of 5.915 ft is larger than the assumed embed depth of 4.373ft. This design is not safe. Hence, we need to re-iterate with a larger assumed depth. This process must be repeated until the assumed depth converges to equal the calculated depth. That will be the solution to describe the minimum required embed

Step 3: Re-iterate with assuming d value larger than db from step 2

Trial #c, Assume dc = 5.35 ft

$$dc := 5.35 \text{ ft}$$

$$S3c := pp \cdot dc$$

$$S3c = 535 \text{ psf}$$

Calculate minimum depth, d (ft) based on the assumed dc

$$d := \sqrt[2]{\left(\frac{4.25 \cdot P \cdot h}{S3c \cdot b}\right)} = 5.348 \text{ ft}$$

$$d = 5.348 \text{ ft} = dc = 5.35 \text{ ft}$$

The Calculated depth equals the assumed depth. Hence, the minimum embedment needed to support the applied lateral loads is **5.35 ft**.

It is important to note that ENERCALC performs the iterations automatically until it converges on a solution that represents the min embed. Then the depth is rounded up slightly. Hence, ENERCALC reports the final value as **5.375 ft**.

See the following ENERCALC printed calculation report for comparison

Pole Footing Embedded in Soil

Project File: Pole Footing.ec6

LIC#: KW-06000215, Build:20.25.06.16

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DESCRIPTION: Constrained Pole Footing

Code References

Calculations per IBC 2021 1807.3
 Load Combinations Used : IBC 2021

General Information

Pole Footing Shape Circular
 Pole Footing Diameter 30.0 in
 Calculate Min. Depth for Allowable Pressures
 Lateral Restraint at Ground Surface
 Allow Passive 100.0 pcf
 Max Passive 1,800.0 psf

Controlling Values

Governing Load Combination **D+0.60W**
 Lateral Load 1.80 k
 Moment 9.0 k-ft

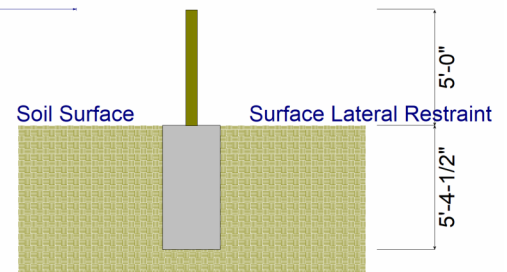
Restraint @ Ground Surface

Pressure at Depth
 Actual **529.58** psf
 Allowable **537.50** psf
 Surface Restraint Force 5,358.14 lbs

Minimum Required Depth 5.375 ft

Footing Base Area 4.909 ft²
 Maximum Soil Pressure 0.4074 ksf

Point Load



Applied Loads

Lateral Concentrated Load (k)		Lateral Distributed Loads (k)		Applied Moment (kft)	Vertical Load (k)
D : Dead Load	k		k/ft	k-ft	2.0 k
Lr : Roof Live	k		k/ft	k-ft	k
L : Live	k		k/ft	k-ft	k
S : Snow	k		k/ft	k-ft	k
W : Wind	3.0 k		k/ft	k-ft	k
E : Earthquake	k		k/ft	k-ft	k
H : Lateral Earth	k		k/ft	k-ft	k
Load distance above ground surface	5.0 ft	TOP of Load above ground surface	ft		
		BOTTOM of Load above ground surface	ft		

Load Combination Results

Load Combination	Forces @ Ground Surface		Required Depth - (ft)	Pressure at Depth		Soil Increase Factor
	Loads - (k)	Moments - (ft-k)		Actual - (psf)	Allow - (psf)	
D Only	0.000	0.000	0.13	0.0	12.5	1.000
+D+0.60W	1.800	9.000	5.38	529.6	537.5	1.000
+D+0.450W	1.350	6.750	4.88	482.8	487.5	1.000
+0.60D+0.60W	1.800	9.000	5.38	529.6	537.5	1.000
+0.60D	0.000	0.000	0.13	0.0	12.5	1.000