
Description:

Pole foundation without surface restraint by IBC 2006 Formula 18-1.

Design Criteria:

Maximum allowable soil bearing pressure: $q := 1500 \cdot \text{psf}$

Presumptive allowable lateral pressure per foot depth for soil type from table 1804.2: $s_1 := 100 \cdot \frac{\text{psf}}{\text{ft}}$

Reference deflection for the Presumptive lateral pressure: $\Delta_{\text{ref}} := \frac{1}{4} \cdot \text{in}$

Geometry:

Height of load above ground: $h := 5 \cdot \text{ft}$

Width of pole: $b := 18 \cdot \text{in}$

Initial guess of embedment: $d_i := 3 \cdot \text{ft}$

Loading:

Lateral load at top: $P := .48 \cdot \text{kip}$

Design:

Allowable Deflection for isolated pole: $\Delta_{\text{all}} := \frac{1}{2} \cdot \text{in}$

Allowable lateral soil bearing pressure: $S_1 := \min \left(s_1 \cdot 0.333 \cdot d_i \cdot \frac{\Delta_{\text{all}}}{\Delta_{\text{ref}}}, q \right)$ $S_1 = 200 \text{ psf}$

$A := \frac{2.34 \cdot P}{S_1 \cdot b}$ $A = 3.75 \text{ ft}$

Required embedment depth: $d := \frac{A}{2} \cdot \left(1 + \sqrt{1 + \frac{4.36 \cdot h}{A}} \right)$ $d = 6.77 \text{ ft}$

Procedures as specified in Structural Engineering Handbook 3rd Ed., Gaylord and Gaylord
pages 7-39

$d := \frac{1.18 \cdot P}{S_1 \cdot b} \cdot \left(1 + \sqrt{1 + \frac{1.88 \cdot b \cdot S_1 \cdot h}{P}} \right)$ $d = 6.84 \text{ ft}$

$M_{\text{max}} := P \cdot (h + 0.34 \cdot d)$ $M_{\text{max}} = 3.52 \text{ k} \cdot \text{ft}$

Healy Paper:

Soil density: $\gamma_s := 100 \text{pcf}$

Friction angle of the soil: $\phi := 20 \text{deg}$

Passive Pressure coefficient: $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 2.04$

Given
$$d^3 - \left[\frac{P \cdot (h + d)}{\gamma_s \cdot b \cdot (K_p \div 4)} \right] = 0 \text{ft}^3$$
 $D := \text{Find}(d)$ $D = 3.81 \text{ft}$

AASHTO Standard Spec ofr Luminaires, etc. Article 13.6.1:

Safety Factor: $SF := 2$

Factored Loading: $P_u := SF \cdot P$

Given
$$d^3 - \left(\frac{2 \cdot P_u \cdot d}{\gamma_s \cdot b \cdot K_p} \right) - \left(\frac{2 \cdot P_u \cdot h}{\gamma_s \cdot b \cdot K_p} \right) = 0 \text{ft}^3$$
 $D := \text{Find}(d)$ $D = 3.81 \text{ft}$