

### Geometry:

Footing length:  $A := 8\text{ft}$

Footing width:  $B := 8\text{ft}$

Footing Thickness:  $T := 18\text{in}$

Soil Cover:  $s_{ov} := 12\text{in}$

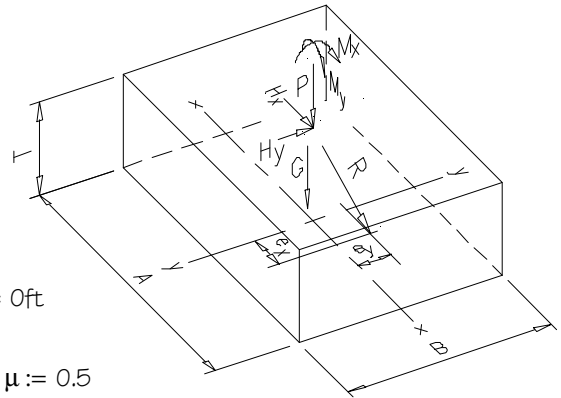
### Soil Properties:

Unit Weight:  $\gamma_e := 100\text{pcf}$

Bouyancy:  $D_w := 0\text{ft}$

Soil Spring Constant:  $k_s := 100\cdot\text{kcf}$

Friction Factor:  $\mu := 0.5$



### Loading to the top of the footing:

Vertical Load:  $P := 20\text{kips}$

Lateral Load:  $H_x := 5\text{kips}$

Lateral Load:  $H_y := 0\text{kips}$

Distance to  $H_x$ :  $d_x := 54\text{in}$

Distance to  $H_y$ :  $d_y := 0\text{in}$

y-axis moment:  $M_{yt} := 50\text{k'}$

x-axis moment:  $M_{xt} := 0\text{k'}$

Footing Weight:  $G := \gamma_c \cdot A \cdot B \cdot T$

$G = 14.40\text{ kips}$

Soil Cover:  $W_s := \gamma_e \cdot A \cdot B \cdot s_{ov}$

$W_s = 6.40\text{ kips}$

$$8 \cdot 8 \cdot 1.5 \cdot 15 = 14.40$$

Bouyancy Uplift:  $U_b := \gamma_w \cdot A \cdot B \cdot D_w$

$U_b = 0.0\text{ kips}$

$$8 \cdot 8 \cdot 1 = 6.40$$

### Determine Eccentricities in each direction:

Vert. Force:  $V := P + G + W_s - U_b$

$V = 40.8\text{ kips}$

Ave. Pressure:  $p := \frac{V}{A \cdot B}$

$p = 637\text{ psf}$

y-axis Moment:  $M_y := H_x \cdot d_x + M_{yt}$

$M_y = 72.5\text{ k'}$

y-axis resisting:  $M_{r,y} := \frac{V \cdot A}{2}$

$M_{r,y} = 163.2\text{ k'}$

$$e_x := \left( \frac{A}{2} - \frac{M_{r,y} - M_y}{V} \right) - \epsilon$$

$e_x = 1.78\text{ ft}$

$$A' := 0.5 \cdot A - e_x$$

$A' = 2.22\text{ ft}$

x-axis Moment:  $M_x := H_y \cdot d_y + M_{xt}$

$M_x = 0.0\text{ k'}$

x-axis resisting:  $M_{r,x} := \frac{V \cdot B}{2}$

$M_{r,x} = 163.2\text{ k'}$

$$e_y := \left( \frac{B}{2} - \frac{M_{r,x} - M_x}{V} \right) - \epsilon$$

$e_y = -0.00\text{ ft}$

$$B' := .5 \cdot B - e_y$$

$B' = 4.00\text{ ft}$

$$\frac{e_x}{A} = 0.22$$

$$\frac{e_y}{B} = -0.00$$

$$\alpha := \frac{e_x}{A} + \frac{e_y}{B}$$

$$\alpha = 0.222$$

Determine safety factors:

$$\text{Safety Factor on Sliding: } SF_{sl} := \frac{\mu \cdot V}{\sqrt{(H_x^2 + H_y^2 + .01 \text{kips}^2)}} \quad SF_{sl} = 4.08 \quad \text{if}(SF_{sl} > .75 \cdot 1.5, \text{OK}, \text{NG}) = \text{"O.K."}$$

$$\text{Safety Factor on Overturning: } SF_{ov} := \frac{0.5 \cdot V}{\sqrt{\left(\frac{M_x}{B}\right)^2 + \left(\frac{M_y}{A}\right)^2}} \quad SF_{ov} = 2.25 \quad \text{if}(SF_{ov} > .75 \cdot 2, \text{OK}, \text{NG}) = \text{"O.K."}$$

Determine correct zone:

$$\text{zone} := \text{if} \left[ \alpha < \frac{1}{6}, \text{"V"}, \text{if} \left[ \frac{e_y}{B} \leq \frac{1}{3} \cdot \left( \frac{1}{2} + \frac{e_x}{A} \right), \text{if} \left[ \frac{e_x}{A} \leq \frac{1}{3} \cdot \left( \frac{1}{2} + \frac{e_y}{B} \right), \text{"IV"}, \text{"III"} \right], \text{if} \left[ \frac{e_x}{A} \leq \frac{1}{3} \cdot \left( \frac{1}{2} + \frac{e_y}{B} \right), \text{"III"}, \text{"I"} \right] \right] \right]$$

$$\text{zone} = \text{"II"}$$

Solve for the maximum bearing pressure:

**For Contract application, delete this line and all zone calculations which do not apply.**

Zone II: If  $e_y/B < 1/4$  and  $e_x/A > 1/3(1/2 + e_y/B)$ :

$$S := \frac{B}{12} \cdot \left[ \left( \left| \frac{B}{e_y} \right| \right) + \sqrt{\frac{B^2}{e_y^2} - 12} \right]$$

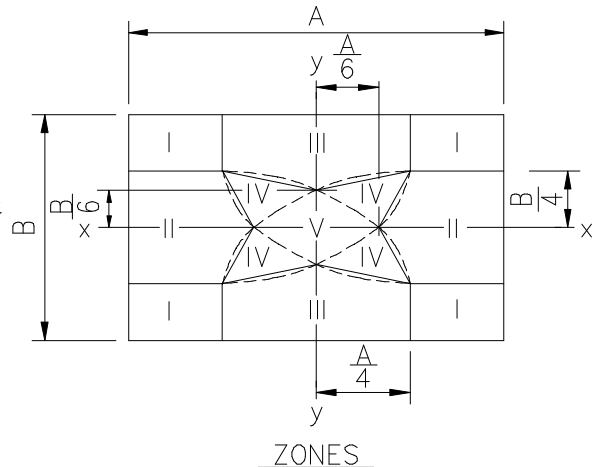
$$S = 10666.67 \text{ ft}$$

$$\tan := \frac{3}{2} \cdot \frac{A - 2e_x}{S + e_y}$$

$$\tan = 0.00$$

$$f_2 := \frac{12V}{B \cdot \tan} \cdot \frac{B + 2S}{B^2 + 12S^2}$$

$$f_2 = 1529 \text{ psf}$$



For  $M_x = 0$ , the following formulas apply:

$$x := 3A' - \frac{A}{2}$$

$$x = 2.67 \text{ ft}$$

$$p_x := \frac{f_2 \cdot x}{3 \cdot A'}$$

$$p_x = 612 \text{ psf}$$

$$M_b := \left[ 0.5 \left[ p_x - (s_{ov} \cdot \gamma_e + T \cdot \gamma_c) \right] \cdot \left( \frac{A}{2} \right)^2 + 0.5 \cdot (f_2 - p_x) \cdot \frac{A^2}{6} \right] \cdot B$$

$$M_b = 57.5 \text{ k'}$$

$$M_t := \left[ 0.5 \left( s_{ov} \cdot \gamma_e + T \cdot \gamma_c \right) \cdot \left( \frac{A}{2} \right)^2 - p_x \cdot \frac{x^2}{6} \right] \cdot B$$

$$M_t = 14.97 \text{ ft} \frac{\text{k}}{\text{ft}}$$

$$A_{req} := \frac{M_b}{24 \text{ ksi} \cdot 0.89 \cdot 1.33 \cdot (T - 3 \text{ in} - 1.5 \cdot 75 \text{ in})}$$

$$A_{req} = 1.75 \text{ in}^2$$

Zone III: If  $e_x/A < 1/4$  and  $e_y/B > 1/3(1/2 + e_x/A)$ :

$$S := \frac{A}{12} \cdot \left( \left| \frac{A}{e_x} \right| + \sqrt{\frac{A^2}{e_x^2} - 12} \right) \quad S = 4.92 \text{ ft}$$

$$\tan := \frac{3}{2} \cdot \frac{B - 2e_y}{S + e_x} \quad \tan = 1.79$$

$$f_3 := \frac{12V}{A \cdot \tan} \cdot \frac{A + 2S}{A^2 + 12S^2} \quad f_3 = 1.7 \text{ ksf}$$

Zone IV: If  $e_y/B < 1/4$  and  $e_x/A < 1/4$ :

$$f_4 := \frac{V}{A \cdot B} \cdot \alpha \cdot [12 - 3.9 \cdot (6\alpha - 1) \cdot (1 - 2\alpha) \cdot (2.3 - 2\alpha)]$$

$$f_4 = 1509 \text{ psf}$$

Zone V: If  $\alpha < 0.167$ :  $f_5 := \left( p + \frac{6 \cdot M_x}{A \cdot B^2} + \frac{6 \cdot M_y}{B \cdot A^2} \right)$

$$f_5 = 1487 \text{ psf}$$

Zone I: If  $e_y/B > 1/4$  and  $e_x/a > 1/4$ :

Trial location of zero pressure:

$$x' := \frac{p}{p + \frac{6 \cdot M_x}{A \cdot B^2} + \frac{6 \cdot M_y}{B \cdot A^2} - p} \cdot \sqrt{A^2 + B^2} \cdot .667$$

$$x' = 5.66 \text{ ft}$$

$$s_1 := 0.5 \cdot \left( \sqrt{A^2 + B^2} - x' \right)$$

$$s_1 = 2.83 \text{ ft}$$

$$w_1 := 2 \cdot s_1$$

$$w_1 = 5.65 \text{ ft}$$

$$I_{\text{total}} := \frac{w_1 \cdot s_1^3}{36} + \frac{w_1 \cdot s_1}{2} \cdot \left( x' + \frac{s_1}{3} \right)^2 + \left( \frac{w_1 + \sqrt{A^2 + B^2}}{2} \right) \cdot \frac{x'^3}{3}$$

$$I_{\text{total}} = 865.1 \text{ ft}^4$$

$$z := \sqrt{e_x^2 + e_y^2}$$

$$z = 1.78 \text{ ft}$$

$$M_{zz} := V \cdot \left( z + \frac{x'}{2} \right)$$

$$M_{zz} = 188.0 \text{ k'}$$

$$q_1 := \frac{M_{zz} \cdot (s_1 + x')}{I_{\text{total}}}$$

$$q_1 = 1844 \text{ psf}$$

$$q_2 := \frac{M_{zz}}{I_{\text{total}}} \cdot \frac{x'}{2}$$

$$q_2 = 615 \text{ psf}$$

$$V_1 := \frac{2 \cdot M_{zz}}{I_{\text{total}}} \cdot \left[ \frac{(s_1 + x') \cdot [(s_1 + x')^2 - x'^2]}{2} - \frac{[(s_1 + x')^3 - x'^3]}{3} \right]$$

$$V_1 = 11.5 \text{ kips}$$

$$V_2 := x' \cdot \left( \frac{w_1 + \sqrt{A^2 + B^2}}{2} \right) \cdot q_2$$

$$V_2 = 29.5 \text{ kips}$$

$$V'_q := V_1 + V_2$$

$$V'_q = 41.0 \text{ kips}$$

$$h := \frac{x' \cdot V}{0.5 \cdot V}$$

$$h = 11.32 \text{ ft}$$

$$f_1 := \frac{V \cdot (0.5 \cdot h) \cdot h}{h^4 \div 6}$$

$$f_1 = 954 \text{ psf}$$

$$\Delta := \frac{f_1}{k_s}$$

$$\Delta = 0.010 \text{ ft}$$

$$\Theta := \frac{\Delta}{h}$$

$$\Theta = 0.001$$

Note: Zone 1 needs to be verified with RISA.