

Hand Calculation

Problem Statement:

Determine the force applied on each pile

Total Applied Force $Q := 380 \text{ kip}$
Load location in the x-direction $x_a := -1.5 \text{ ft}$
Load location in the y-direction $y_a := 2.5 \text{ ft}$

Number of piles $n := 6$
Distance between each pile in x-direction $x := 2.5 \text{ ft}$
Distance between each pile in y-direction $y := 4 \text{ ft}$

Locations of Each Pile:

Pile 1
 $x_1 := -2.5 \text{ ft}$ $y_1 := -4 \text{ ft}$

Pile 2
 $x_2 := 2.5 \text{ ft}$ $y_2 := -4 \text{ ft}$

Pile 3
 $x_3 := -2.5 \text{ ft}$ $y_3 := 0 \text{ ft}$

Pile 4
 $x_4 := 2.5 \text{ ft}$ $y_4 := 0 \text{ ft}$

Pile 5
 $x_5 := -2.5 \text{ ft}$ $y_5 := 4 \text{ ft}$

Pile 6
 $x_6 := 2.5 \text{ ft}$ $y_6 := 4 \text{ ft}$

Solution:

Step 1: Calculate moment at the load location

$$M_y := Q \cdot x_a = -570 \text{ ft}\cdot\text{kip}$$

$$M_x := Q \cdot y_a = 950 \text{ ft}\cdot\text{kip}$$

Step 2: Calculate load on each pile

$$x_n := \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{bmatrix} = \begin{bmatrix} -2.5 \\ 2.5 \\ -2.5 \\ 2.5 \\ -2.5 \\ 2.5 \end{bmatrix} \text{ ft} \quad y_n := \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \end{bmatrix} = \begin{bmatrix} -4 \\ -4 \\ 0 \\ 0 \\ 4 \\ 4 \end{bmatrix} \text{ ft}$$

$$Q_1 := \frac{Q}{n} + \frac{M_y \cdot x_1}{\sum_{i=1}^6 (x_n)_i^2} + \frac{M_x \cdot y_1}{\sum_{i=1}^6 (y_n)_i^2} = 41.958 \text{ kip}$$

$$Q_2 := \frac{Q}{n} + \frac{M_y \cdot x_2}{\sum_{i=1}^6 (x_n)_i^2} + \frac{M_x \cdot y_2}{\sum_{i=1}^6 (y_n)_i^2} = -34.042 \text{ kip}$$

$$Q_3 := \frac{Q}{n} + \frac{M_y \cdot x_3}{\sum_{i=1}^6 (x_n)_i^2} + \frac{M_x \cdot y_3}{\sum_{i=1}^6 (y_n)_i^2} = 101.333 \text{ kip}$$

$$Q_4 := \frac{Q}{n} + \frac{M_y \cdot x_4}{\sum_{i=1}^6 (x_n)_i^2} + \frac{M_x \cdot y_4}{\sum_{i=1}^6 (y_n)_i^2} = 25.333 \text{ kip}$$

$$Q_5 := \frac{Q}{n} + \frac{M_y \cdot x_5}{\sum_{i=1}^6 (x_n)_i^2} + \frac{M_x \cdot y_5}{\sum_{i=1}^6 (y_n)_i^2} = 160.708 \text{ kip}$$

$$Q_6 := \frac{Q}{n} + \frac{M_y \cdot x_6}{\sum_{i=1}^6 (x_n)_i^2} + \frac{M_x \cdot y_6}{\sum_{i=1}^6 (y_n)_i^2} = 84.708 \text{ kip}$$

See the following ENERCALC printed calculation report for comparison



Pile Group Analysis

Project File: Pile Group Analysis.ec6

LIC# : KW-06000215, Build:20.25.10.02

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DESCRIPTION: Pile Group Column 1

Code References

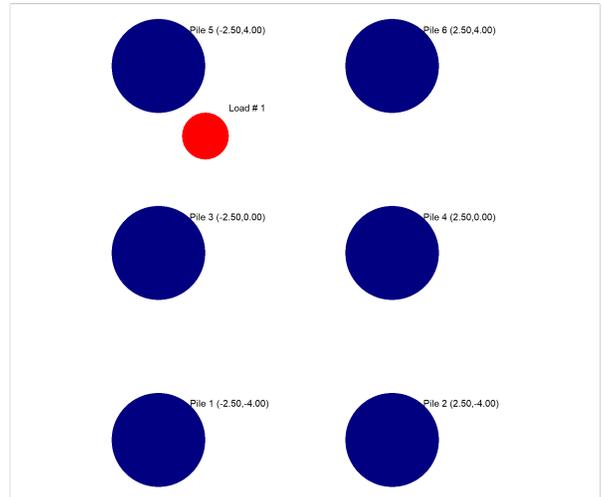
Governing Code : IBC 2018, CBC 2019
 Load Combinations Used : IBC 2018

General Information

Applied Concentrated Vertical Load

	Load #1	Load #2	Load #3
Dead Load	380.0 k	k	k
Roof Live	k	k	k
Floor Live	k	k	k
Snow	k	k	k
Wind	k	k	k
Seismic	k	k	k
Earth	k	k	k
Load Distance from....			
X Datum	-1.50		ft
Y Datum	2.50		ft

Total # of Piles = 6



SUMMARY

Xcg from Datum	0.00 ft	Y-Y Axis Inertia	37.50 ft ⁴
Ycg from Datum	0.00 ft	X-X Axis Inertia	64.00 ft ⁴
		X-Y Axis Inertia	0.00 ft ⁴
		XY ² Inertia	0.00 ft ⁸

Pile Locations & Max/Min Vertical Loads

Pile Location	Maximum Force for Pile		Minimum Force for Pile			
	X Location	Y Location	Force	Load Combination	Force	Load Combination
Pile 1	-2.500 ft	-4.000 ft	41.958 k	D Only	41.958 k	D Only
Pile 2	2.500 ft	-4.000 ft	-34.042 k	D Only	-34.042 k	D Only
Pile 3	-2.500 ft	0.000 ft	101.333 k	D Only	101.333 k	D Only
Pile 4	2.500 ft	0.000 ft	25.333 k	D Only	25.333 k	D Only
Pile 5	-2.500 ft	4.000 ft	160.708 k	D Only	160.708 k	D Only
Pile 6	2.500 ft	4.000 ft	84.708 k	D Only	84.708 k	D Only

Detailed Analysis Results

Positive Values Indicate Downward Load

Pile ID	X Loc.	Y Loc.	Load Combination	Component Forces per Pile			Pile Force
				Load/ Num Piles	X-X Moment	Y-Y Moment	
Pile 1	-2.500 ft	-4.000 ft	D Only	63.333 k	38.000 k	-59.375 k	41.958 k
Pile 2	2.500 ft	-4.000 ft	D Only	63.333 k	-38.000 k	-59.375 k	-34.042 k
Pile 3	-2.500 ft	0.000 ft	D Only	63.333 k	38.000 k	0.000 k	101.333 k
Pile 4	2.500 ft	0.000 ft	D Only	63.333 k	-38.000 k	0.000 k	25.333 k
Pile 5	-2.500 ft	4.000 ft	D Only	63.333 k	38.000 k	59.375 k	160.708 k
Pile 6	2.500 ft	4.000 ft	D Only	63.333 k	-38.000 k	59.375 k	84.708 k