Hand Calculation

Problem Statement:
Determine load carrying capacity and minimum adjacent load

Load ID #1	
Load Support Width	$b := 3\ in$
Load Support Length	$L := 6\ in$
Applied load (Dead)	$P_u := 6\ kip$
Soil Modulus of Subgrade Reaction	$k_s := 100\ pci$
Concrete Compressive Strength	$f'_c := 4000\ psi$
Concrete Elastic Modulus	$E_c := 3605000\ psi$
Poisson's Ratio	$\mu := 0.150$
Concrete Tensile Strength Factor	$f'_t := 7.50$
Required Factor of Safety	$FS := 6.0$
Slab Thickness	$d := 5.0\ in$
Load Reduction Factor	$\beta := 1.0$

Solution:

Step 1: Calculate the Equivalent Bearing Radius

$$R_1 := \frac{\sqrt{b \cdot L}}{2} = 2.121\ in$$

Step 2: Calculate Concrete Tensile Strength

$$F_r := f'_t \cdot \sqrt{psi} \cdot \sqrt{f'_c} = 474.34165\ psi$$

Step 3: Calculate Nominal Load Carrying Capacity

$$P_n := \beta \cdot 1.72 \cdot \left(\frac{k_s \cdot R_1}{E_c} \cdot 10000 + 3.6 \right) F_r \cdot d^2 = 85.43\ kip$$

$$\frac{P_n}{P_u} = 14.24 \quad > \quad FS = 6 \quad \textbf{PASS} \quad \checkmark$$

Step 4: Calculate the Radius of Relative Stiffness

$$b := \left(\frac{E_c \cdot d^3}{12 \cdot \left(1 - \mu^2\right) \cdot k_s} \right)^{0.25} = 24.896 \ in$$

Step 5: Calculate Minimum Adjacent Load Distance

$$L_{min} := 1.5 \cdot b = 37.344 \ in$$

See the following ENERCALC printed calc report for comparison

Point Load on Slab

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DESCRIPTION: Point Load on Slab

Code References

Governing Code : IBC 2024
Calculations based on the Azzi & Laird (2008) simplified analytical method derived from Shentu, Jiang, and Hsu (1997)
Load Combinations Used : ASCE 7-22 / IBC 2024 Rho (or Omega) = 1.00

Analytical Values

d - Slab Thickness	5.0 in	Ks - Soil Modulus of Subgrade Reaction	100.0 pci
FS - Req'd Factor of Safety	6.0 : 1	Ec - Concrete Elastic Modulus	3,605.0 ksi
		f'c - Concrete Compressive Strength	4.0 ksi
		μ - Poisson's Ratio	0.150
		ft' - Concrete Tensile Strength Factor	7.50
		β - Load Reduction Factor	1.0
		Min. Adjacent Load Distance	37.344 in

Analysis Formulas

Pn = β * 1.72 [(Ks R1 / Ec) 10,000 + 3.6] Fr d^2

Ks = Soil modulus of subgrade reaction
R1 = 50% plate average dimension = sqrt(PlWid * PlLen) /2
Ec = Concrete elastic modulus
Fr - Concrete modulus of rupture = ft' * sqrt(f'c)
d - Slab Thickness
β - Load Reduction Factor

Min Adjacent Load Distance = 1.5 * ([Ec d^3 / (12 * (1- u^2) Ks] ^ 1/4)

Ec = Concrete elastic modulus
d - Slab Thickness
μ - Poisson's Ratio
Ks = Soil modulus of subgrade reaction

Load & Capacity Table

Load ID	Plate (in) Wid	Len	R1 (in)	Applied Concentrated Load on Plate - (kip) D	Lr	L	S	W	E	Governing Ld Comb	Pu (kip)	Pn (kip)	Check
#1	3.00	6.00	2.12	6.00						D Only	6.0	85.4	Pass, FS=14.24 >= 6