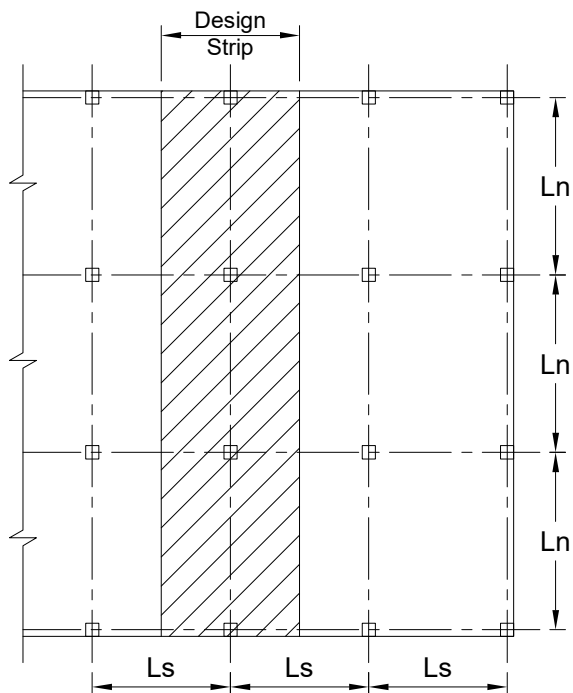




Design Two-Way Slab without Beams Analyzed by the Direct Design Method

As per ACI 318-11 Chapter 13



System

Longer Span for Two-Way Slab, L_n =		18.00 ft
Shorter Span for Two-Way Slab, L_s =		14.00 ft
Thickness of Slab, h =		7.00 in
Concrete Cover, co =		1.25 in
Depth of Slab, d =	$h - co$	= 5.75 in
Square Column Dimension, b_c =		16.00 in
Width of Column Strip, b =	$L_s * 12 / 2$	= 84 in
Width of Middle Strip, b_m =	$L_s * 12 - b$	= 84 in

Load

Slab Self Weight, q_s =	$h/12 * 150$	= 87.50 psf
Partition Load, q_p =		20.00 psf
Dead Load, q_D =	$q_s + q_p$	= 107.50 psf
Live Load, q_L =		40.00 psf
Ultimate Load, q_U =	$1.2 * q_D + 1.6 * q_L$	= 193.00 psf

Material Properties

Concrete Strength, f'_c =		3000 psi
Yield Strength of Reinforcement, f_y =		60000 psi
Tension Strength Reduction Factor (According to Cl.9.3.2 of ACI318), Φ =		0.90
Minimum Reinforcement Ratio (According to Cl.7.12.2 of ACI318),		



$$\rho_{min} = \text{IF}(f_y \leq 50000; 0.002; \text{IF}(f_y \geq 77143; 0.0014; 0.0018)) = 0.0018$$

Total Static Moment of Slab

Total Factored Static Moment Per Span (According to Eq. 13-4 of ACI318),

$$M_0 = \frac{q_U * L_s}{8 * 1000} * \left(L_n - \frac{b_c}{12} \right)^2 = 93.82 \text{ kip*ft}$$

Flexural Reinforcement Required for Negative Moment of Column Strip

$$R_{n1} = \frac{M_0 * 12000 * 0.53}{\phi * b * d^2} = 239 \text{ psi}$$

$$\text{Ratio of RFT, } \rho_1 = \frac{0.85 * f'_c}{f_y} * \left(1 - \sqrt{1 - \frac{2 * R_{n1}}{0.85 * f'_c}} \right) = 0.00419$$

$$\text{Area of Steel, } A_{s1_Req} = \text{MAX}(\rho_1; \rho_{min}) * b * d = 2.02 \text{ in}^2$$

$$\text{Provided Reinforcement, Bar} = \text{SEL}(\text{"ACI/Bar"; Bar; }) = \text{No.6}$$

$$\text{Provided Reinforcement, } A_{sb} = \text{TAB}(\text{"ACI/Bar"; Asb; Bar=Bar}) = 0.44 \text{ in}^2$$

$$\text{Number of Bars, } n = 5$$

$$\text{Vertical Reinforcement, } A_{s1_Prov} = A_{sb} * n = 2.20 \text{ in}^2$$

$$\text{Check Validity} = \text{IF}(A_{s1_Prov} \geq A_{s1_Req}; \text{"Valid"; "Invalid"}) = \text{Valid}$$

Flexural Reinforcement Required for Positive Moment of Column Strip

$$R_{n2} = \frac{M_0 * 12000 * 0.31}{\phi * b * d^2} = 140 \text{ psi}$$

$$\text{Ratio of RFT, } \rho_2 = \frac{0.85 * f'_c}{f_y} * \left(1 - \sqrt{1 - \frac{2 * R_{n2}}{0.85 * f'_c}} \right) = 0.00240$$

$$\text{Area of Steel, } A_{s2_Req} = \text{MAX}(\rho_2; \rho_{min}) * b * d = 1.16 \text{ in}^2$$

$$\text{Provided Reinforcement, Bar} = \text{SEL}(\text{"ACI/Bar"; Bar; }) = \text{No.6}$$

$$\text{Provided Reinforcement, } A_{sb} = \text{TAB}(\text{"ACI/Bar"; Asb; Bar=Bar}) = 0.44 \text{ in}^2$$

$$\text{Number of Bars, } n = 3$$

$$\text{Vertical Reinforcement, } A_{s2_Prov} = A_{sb} * n = 1.32 \text{ in}^2$$

$$\text{Check Validity} = \text{IF}(A_{s2_Prov} \geq A_{s2_Req}; \text{"Valid"; "Invalid"}) = \text{Valid}$$

Flexural Reinforcement Required for Negative Moment of Middle Strip

$$R_{n3} = \frac{M_0 * 12000 * 0.17}{\phi * b * d^2} = 77 \text{ psi}$$

$$\text{Ratio of RFT, } \rho_3 = \frac{0.85 * f'_c}{f_y} * \left(1 - \sqrt{1 - \frac{2 * R_{n3}}{0.85 * f'_c}} \right) = 0.00130$$

$$\text{Area of Steel, } A_{s3_Req} = \text{MAX}(\rho_3; \rho_{min}) * b * d = 0.87 \text{ in}^2$$



Provided Reinforcement, Bar=	SEL("ACI/Bar"; Bar;)	=	No.6
Provided Reinforcement, A _{sb} =	TAB("ACI/Bar"; Asb; Bar=Bar)	=	0.44 in ²
Number of Bars, n=			2
Vertical Reinforcement, A _{s3_Prov} =	A _{sb} * n	=	0.88 in ²
Check Validity=	IF(A _{s3_Prov} ≥A _{s3_Req} ; "Valid"; "Invalid")	=	Valid

Flexural Reinforcement Required for Positive Moment of Middle Strip

R _{n4} =	$\frac{M_0 * 12000 * 0.21}{\phi * b * d^2}$	=	95 psi
Ratio of RFT, ρ ₄ =	$\frac{0.85 * f_c}{f_y} * \left(1 - \sqrt{1 - \frac{2 * R_{n4}}{0.85 * f_c}} \right)$	=	0.00161
Area of Steel, A _{s4_Req} =	MAX(ρ ₄ ; ρ _{min}) * b * d	=	0.87 in ²
Provided Reinforcement, Bar=	SEL("ACI/Bar"; Bar;)	=	No.6
Provided Reinforcement, A _{sb} =	TAB("ACI/Bar"; Asb; Bar=Bar)	=	0.44 in ²
Number of Bars, n=			2
Vertical Reinforcement, A _{s4_Prov} =	A _{sb} * n	=	0.88 in ²
Check Validity=	IF(A _{s4_Prov} ≥A _{s4_Req} ; "Valid"; "Invalid")	=	Valid

Design Summary

Area of Reinforcement Required for Negative Moment of Middle Strip,			
A _{s1_Prov} =	A _{s1_Prov}	=	2.20 in ²
Area of Reinforcement Required for Negative Moment of Middle Strip,			
A _{s2_Prov} =	A _{s2_Prov}	=	1.32 in ²
Area of Reinforcement Required for Negative Moment of Middle Strip,			
A _{s3_Prov} =	A _{s3_Prov}	=	0.88 in ²
Area of Reinforcement Required for Positive Moment of Middle Strip,			
A _{s4_Prov} =	A _{s4_Prov}	=	0.88 in ²