Isolated Footing Design(ACI 318-11)

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
58	1	1.000m	1.000m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
58	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
59	2	1.000m	1.000m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
59	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
60	3	1.000m	1.000m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
60	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
61	4	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
61	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
62	5	0.800m	0.800m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
62	#10 @ 105 mm c/c	#10 @ 105 mm c/c	#10 @ 105 mm c/c	#10 @ 105 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
63	6	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
63	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
64	7	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
64	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
65	8	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
65	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
66	9	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
66	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
67	10	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
67	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
68	11	1.000m	1.000m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
68	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
69	12	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel

69	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
70	13	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
70	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

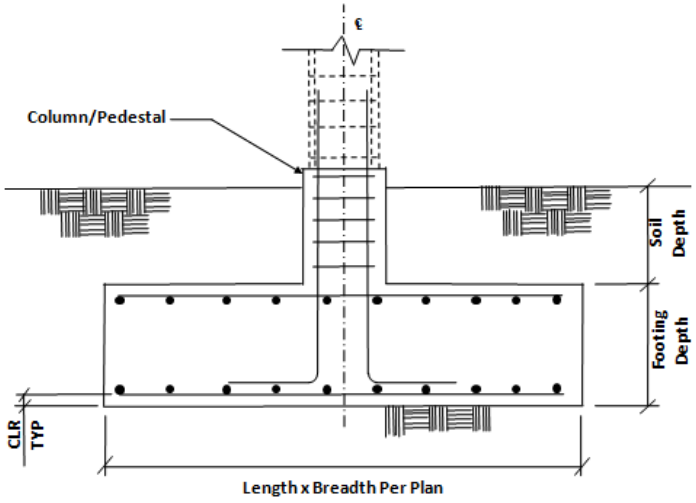
Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
71	14	1.000m	1.000m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
71	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	#12 @ 165 mm c/c	N/A	N/A

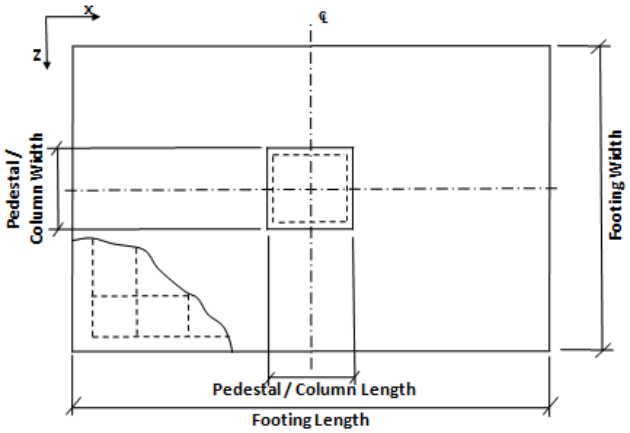
Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
72	15	0.900m	0.900m	0.350m

Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
72	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	#16 @ 365 mm c/c	N/A	N/A

Isolated Footing 58



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) = 0.500m

Initial Width (W_o) = 0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	21.538	-4.350	1.112	0.967	4.488
23	20.550	-3.034	1.464	1.737	1.909
24	21.322	-5.252	1.320	1.426	6.691
25	20.339	-2.987	0.904	0.513	1.811
26	21.111	-5.205	0.761	0.202	6.593
27	21.067	-3.866	2.068	3.062	3.700
28	21.298	-4.530	2.025	2.969	5.130
29	20.363	-3.709	0.199	-1.030	3.372
30	20.594	-4.373	0.156	-1.123	4.803
31	10.852	-0.610	1.139	1.616	-0.998
32	11.881	-3.566	0.948	1.201	5.378

33	10.569	-0.547	0.388	-0.028	-1.129
34	11.598	-3.503	0.197	-0.442	5.246
35	11.540	-1.716	1.943	3.377	1.382
36	11.850	-2.607	1.885	3.252	3.303
37	10.911	-2.397	-0.607	-2.203	2.867
38	10.601	-1.506	-0.550	-2.079	0.946

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	26.977	-5.589	1.334	1.156	5.764
40	24.749	-2.977	2.006	2.629	0.753
41	26.214	-7.184	1.734	2.039	9.826
42	24.346	-2.887	0.935	0.286	0.566
43	25.810	-7.094	0.664	-0.304	9.639
44	25.727	-4.550	3.149	5.133	4.137
45	26.169	-5.820	3.067	4.955	6.876
46	24.390	-4.252	-0.398	-2.630	3.516
47	24.832	-5.522	-0.480	-2.808	6.255
48	16.307	-1.026	1.673	2.346	-1.256
49	17.772	-5.233	1.401	1.756	7.817
50	15.904	-0.936	0.602	0.003	-1.444
51	17.368	-5.143	0.331	-0.587	7.629
52	17.285	-2.599	2.816	4.851	2.128
53	17.727	-3.869	2.734	4.673	4.866
54	15.948	-2.301	-0.731	-2.913	1.507
55	16.390	-3.571	-0.813	-3.091	4.245

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.178 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 1.000 m Governing Load Case : # 24

Width (W_2) = 1.000 m Governing Load Case : # 24

Depth (D_2) = 0.350 m Governing Load Case : # 44

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

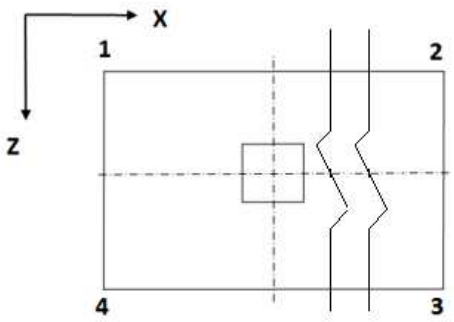
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.906 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
26	**86.0938**	-14.8832	-9.2601	91.7169	0.118
33	21.6012	**32.8542**	34.1484	22.8954	0.000
31	11.3671	20.7775	**44.9486**	35.5382	0.000
24	78.4726	-23.8765	-1.2174	**101.1318**	0.125

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

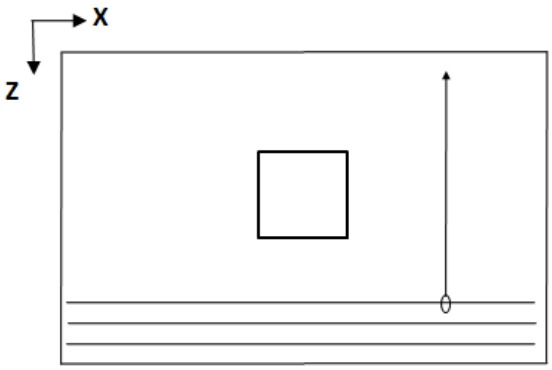
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**88.2264**	0.0000	0.0000	94.7120
33	21.6012	**32.8542**	34.1484	22.8954
31	11.3671	20.7775	**44.9486**	35.5382
24	80.2584	0.0000	0.0000	**106.6964**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 41

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.269	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	6.964	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	7.737	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00025	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00020	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected bar Size = #12

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 12	Area of one bar =	113.097	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.269	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

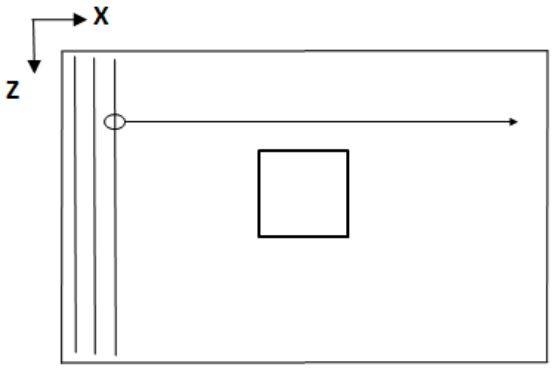
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 45

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.257	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	5.951	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	6.613	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00023	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00017	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected Bar Size = #12

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	0.305	m

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.300	m	
Try bar size # 12	Area of one bar =	113.097	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

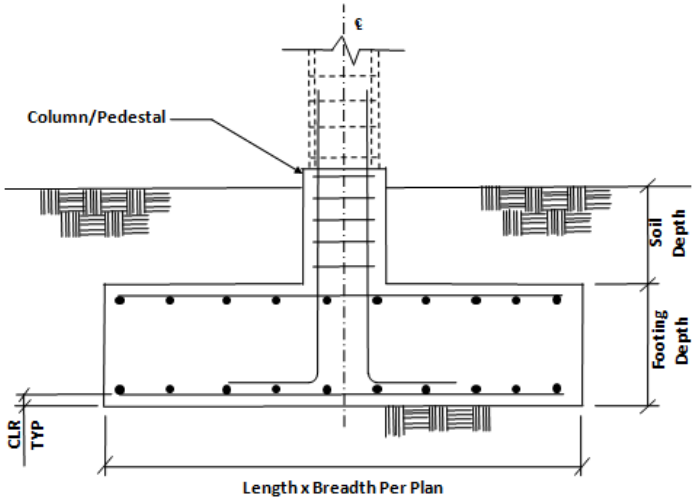
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

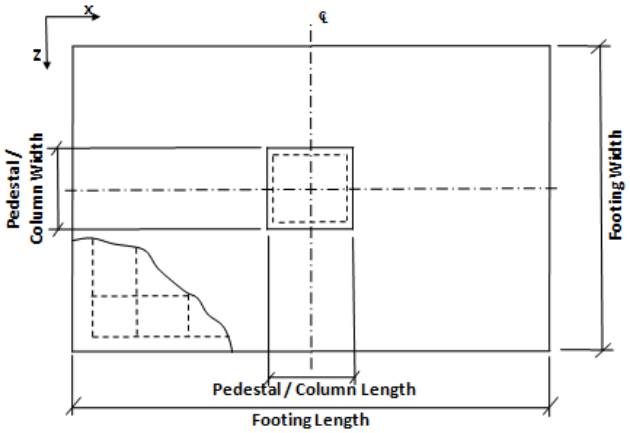
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 59



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	19.154	-4.326	-0.317	-0.538	4.371
23	18.032	-3.108	0.130	0.334	1.887
24	18.970	-5.237	-0.049	-0.015	6.491
25	18.679	-3.163	-0.582	-1.051	1.998
26	19.617	-5.292	-0.761	-1.400	6.602
27	17.602	-3.790	0.902	1.834	3.370
28	17.883	-4.427	0.848	1.730	4.748
29	19.766	-3.973	-1.478	-2.795	3.742
30	20.047	-4.610	-1.532	-2.900	5.119
31	9.641	-0.838	0.412	0.852	-0.824
32	10.891	-3.677	0.174	0.386	5.314

33	10.511	-0.912	-0.544	-1.008	-0.674
34	11.760	-3.750	-0.782	-1.474	5.464
35	9.070	-1.745	1.438	2.845	1.148
36	9.447	-2.600	1.366	2.705	2.997
37	12.332	-2.843	-1.808	-3.468	3.492
38	11.955	-1.988	-1.736	-3.327	1.643

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	23.513	-5.391	-0.384	-0.653	5.446
40	21.212	-3.018	0.472	1.016	0.670
41	22.991	-7.057	0.133	0.353	9.405
42	22.452	-3.123	-0.891	-1.635	0.883
43	24.230	-7.162	-1.230	-2.298	9.618
44	20.400	-4.307	1.930	3.851	3.474
45	20.937	-5.526	1.828	3.651	6.110
46	24.506	-4.654	-2.586	-4.933	4.178
47	25.043	-5.873	-2.688	-5.134	6.814
48	14.542	-1.369	0.574	1.190	-0.994
49	16.321	-5.408	0.234	0.527	7.741
50	15.782	-1.474	-0.789	-1.461	-0.781
51	17.560	-5.513	-1.129	-2.124	7.954
52	13.730	-2.658	2.032	4.026	1.810
53	14.267	-3.877	1.929	3.825	4.446
54	17.836	-3.005	-2.485	-4.759	2.514
55	18.373	-4.224	-2.587	-4.959	5.150

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.167m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 1.000 m Governing Load Case : # 26

Width (W_2) = 1.000 m Governing Load Case : # 26

Depth (D_2) = 0.350 m Governing Load Case : # 47

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

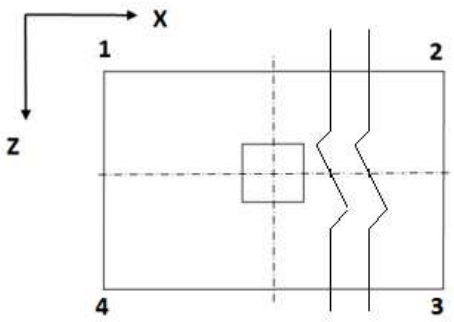
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.906 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
26	**97.6448**	-3.8049	-23.7997	77.6499	0.136
38	66.9041	**38.8386**	-8.3823	19.6832	0.027
31	17.7898	24.1520	**36.1040**	29.7418	0.000
24	86.4113	-13.4762	-13.8609	**86.0266**	0.120

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

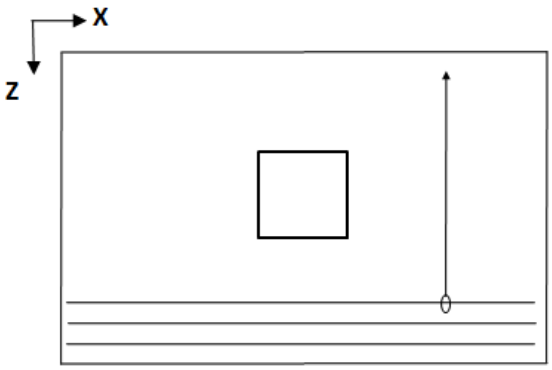
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**103.1982**	0.0000	0.0000	78.8649
38	67.2666	**38.7400**	0.0000	19.5162
31	17.7898	24.1520	**36.1040**	29.7418
24	89.7110	0.0000	0.0000	**89.1998**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 43

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.269	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	6.756	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	7.506	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00025	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00019	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected bar Size = #12

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 12	Area of one bar =	113.097	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.269	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

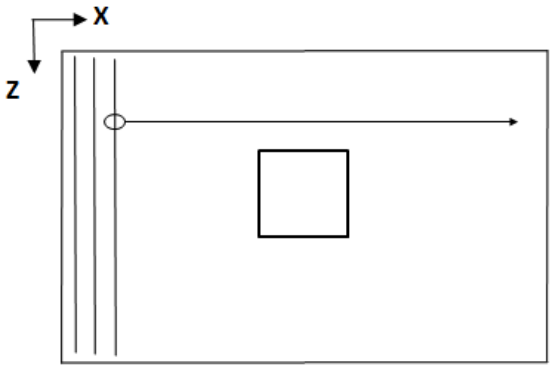
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.257	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	4.899	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.443	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00019	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00014	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected Bar Size = #12

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	0.305	m

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.300	m	
Try bar size # 12	Area of one bar =	113.097	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

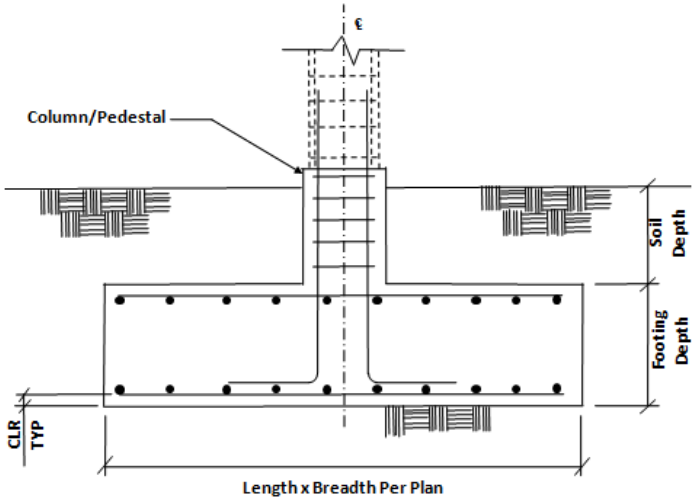
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

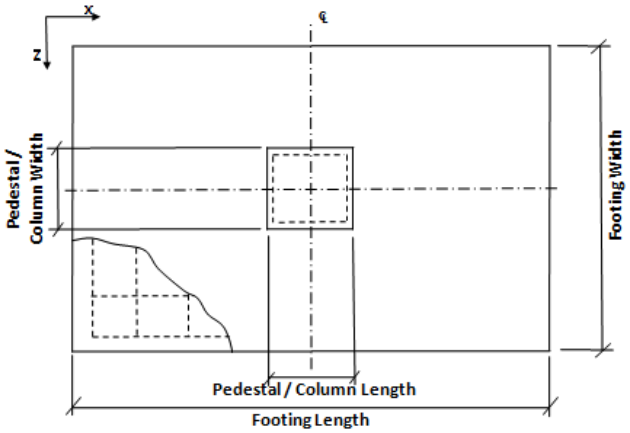
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 60



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	41.636	3.211	-0.705	-0.955	-3.524
23	40.293	4.743	-0.088	0.137	-6.486
24	40.309	1.361	-0.227	-0.088	-0.208
25	39.887	4.749	-1.182	-1.812	-6.500
26	39.903	1.367	-1.322	-2.037	-0.223
27	40.774	3.551	1.145	2.341	-4.269
28	40.779	2.539	1.104	2.273	-2.391
29	39.417	3.571	-2.513	-4.174	-4.317
30	39.422	2.559	-2.555	-4.241	-2.439
31	21.552	3.804	0.405	0.897	-5.882
32	21.574	-0.706	0.219	0.597	2.488

33	21.007	3.812	-1.064	-1.720	-5.902
34	21.029	-0.698	-1.250	-2.020	2.469
35	22.192	2.219	2.044	3.827	-2.936
36	22.198	0.860	1.988	3.736	-0.414
37	20.390	0.886	-2.890	-4.950	-0.478
38	20.383	2.245	-2.834	-4.860	-3.000

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	52.424	4.102	-0.846	-1.153	-4.500
40	49.105	6.932	0.334	0.937	-10.035
41	49.137	0.514	0.069	0.509	1.877
42	48.329	6.943	-1.761	-2.794	-10.062
43	48.360	0.525	-2.026	-3.221	1.849
44	50.015	4.678	2.665	5.103	-5.845
45	50.025	2.741	2.585	4.974	-2.250
46	47.441	4.715	-4.277	-7.258	-5.936
47	47.450	2.778	-4.356	-7.387	-2.341
48	32.309	5.532	0.546	1.236	-8.502
49	32.340	-0.886	0.281	0.809	3.409
50	31.532	5.544	-1.549	-2.494	-8.530
51	31.563	-0.875	-1.814	-2.922	3.382
52	33.218	3.279	2.877	5.402	-4.312
53	33.228	1.342	2.797	5.273	-0.717
54	30.644	3.316	-4.065	-6.959	-4.403
55	30.654	1.379	-4.145	-7.088	-0.808

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.318m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 1.000 m Governing Load Case : # 25

Width (W_2) = 1.000 m Governing Load Case : # 25

Depth (D_2) = 0.350 m Governing Load Case : # 47

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

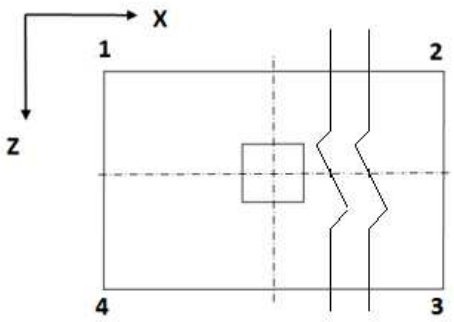
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.906 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
34	**69.3623**	36.8056	7.3074	39.8640	0.000
29	53.6429	**120.4462**	59.8027	-7.0006	0.005
27	8.5570	74.7016	**107.6019**	41.4573	0.000
36	8.6215	17.2016	70.3865	**61.8065**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

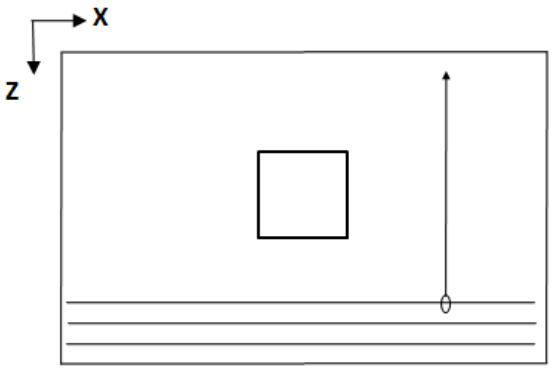
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**69.3623**	36.8056	7.3074	39.8640
29	53.5961	**120.4858**	59.7571	0.0000
27	8.5570	74.7016	**107.6019**	41.4573
36	8.6215	17.2016	70.3865	**61.8065**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 42

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.269	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	8.983	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	9.981	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00033	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00025	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected bar Size = #12

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 12	Area of one bar =	113.097	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.269	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

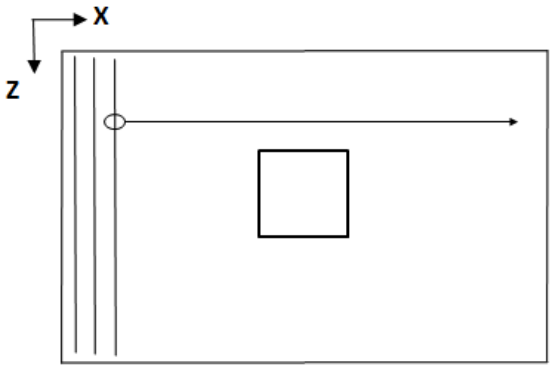
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.257	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	7.372	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.191	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00029	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00022	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected Bar Size = #12

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	0.305	m

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.300	m	
Try bar size # 12	Area of one bar =	113.097	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

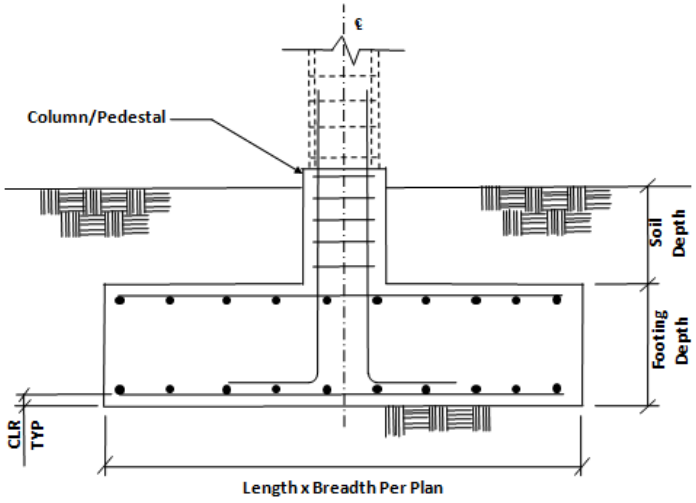
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

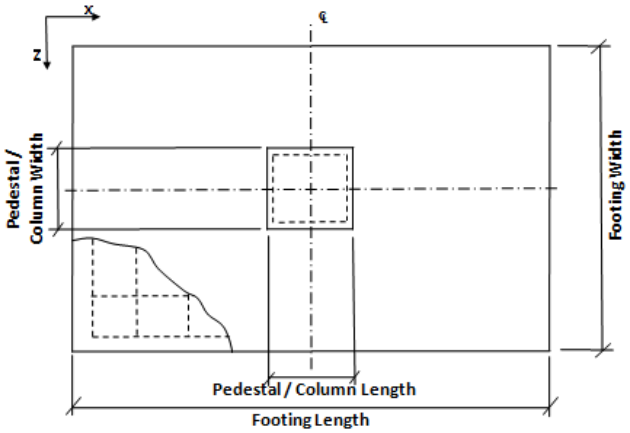
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 61



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	31.906	2.356	1.092	0.940	-2.581
23	30.310	3.820	1.479	1.788	-5.317
24	31.229	0.575	1.424	1.654	0.550
25	30.039	3.881	0.750	0.226	-5.430
26	30.958	0.637	0.695	0.091	0.437
27	30.950	2.610	2.314	3.572	-3.129
28	31.225	1.640	2.298	3.532	-1.374
29	30.043	2.817	-0.123	-1.652	-3.506
30	30.318	1.846	-0.140	-1.693	-1.751
31	15.661	3.229	1.170	1.702	-5.045
32	16.887	-1.098	1.097	1.523	2.777

33	15.296	3.311	0.191	-0.396	-5.197
34	16.522	-1.015	0.118	-0.575	2.625
35	16.512	1.621	2.280	4.074	-2.137
36	16.881	0.318	2.258	4.020	0.220
37	15.671	0.593	-0.992	-2.947	-0.284
38	15.302	1.896	-0.970	-2.893	-2.640

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	40.321	3.032	1.317	1.128	-3.323
40	36.657	5.744	2.056	2.751	-8.442
41	38.402	-0.412	1.953	2.496	2.689
42	36.137	5.862	0.660	-0.241	-8.658
43	37.882	-0.294	0.557	-0.496	2.473
44	37.867	3.459	3.634	6.123	-4.306
45	38.393	1.600	3.603	6.046	-0.946
46	36.146	3.849	-0.990	-3.790	-5.023
47	36.672	1.991	-1.022	-3.867	-1.663
48	23.525	4.680	1.716	2.469	-7.273
49	25.269	-1.477	1.613	2.214	3.859
50	23.005	4.798	0.320	-0.523	-7.489
51	24.750	-1.359	0.217	-0.778	3.642
52	24.735	2.394	3.294	5.840	-3.136
53	25.261	0.536	3.263	5.763	0.223
54	23.013	2.785	-1.330	-4.073	-3.853
55	23.540	0.927	-1.362	-4.150	-0.494

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.250m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 23

Width (W_2) = 0.900 m Governing Load Case : # 23

Depth (D_2) = 0.350 m Governing Load Case : # 45

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

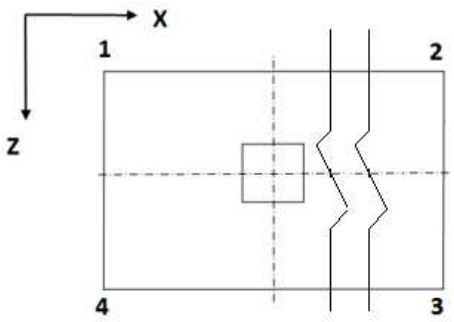
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
34	**66.4880**	17.4312	8.6404	57.6972	0.000
25	-5.6364	**106.1050**	114.1386	2.3972	0.014
23	-19.1575	90.3681	**128.3298**	18.8041	0.035
32	48.3311	-3.7012	27.6971	**79.7294**	0.003

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

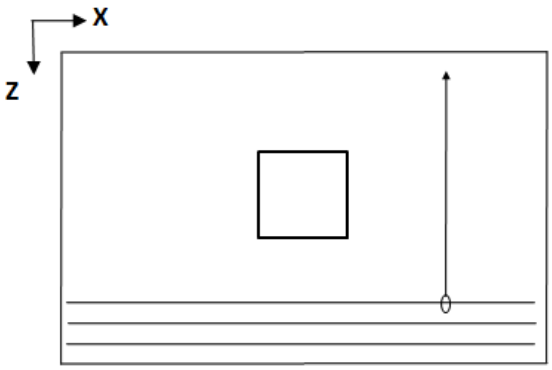
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**66.4880**	17.4312	8.6404	57.6972
25	0.0000	**106.0948**	114.2644	0.0000
23	0.0000	90.0471	**129.5936**	18.0118
32	48.3358	0.0000	27.6993	**79.7626**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 40

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	7.061	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	7.846	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00029	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00022	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.267	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00251	

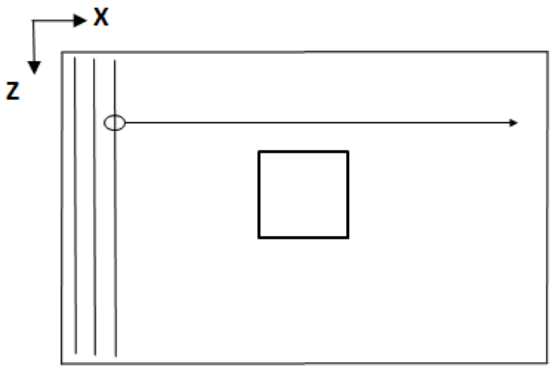
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 44

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	5.697	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	6.330	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00025	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00018	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m	
Try bar size # 16	Area of one bar =	201.064	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

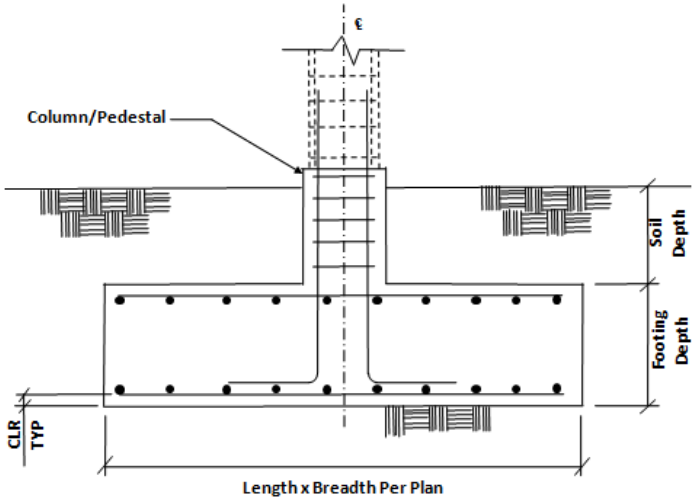
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

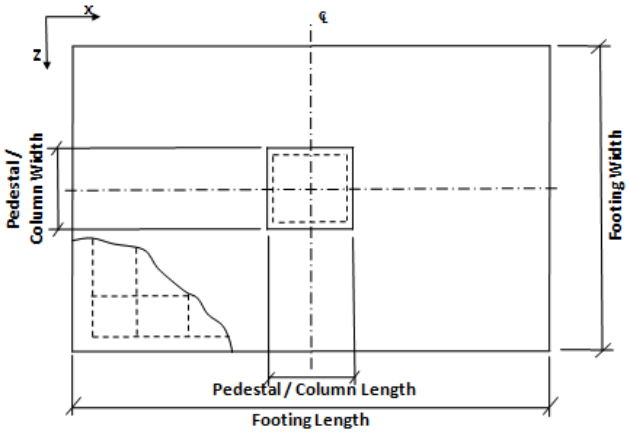
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 62



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.120m
Column Width - Z (B_{col}) :	0.300m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	32.050	-0.178	-1.158	-1.468	0.173
23	31.175	0.171	-0.623	-0.559	-0.376
24	30.947	-0.512	-0.651	-0.588	0.709
25	30.808	0.174	-1.602	-2.266	-0.381
26	30.580	-0.509	-1.631	-2.295	0.705
27	31.525	-0.072	0.515	1.430	0.009
28	31.457	-0.276	0.506	1.421	0.334
29	30.298	-0.061	-2.759	-4.276	-0.005
30	30.230	-0.265	-2.768	-4.284	0.319
31	16.814	0.369	0.057	0.383	-0.639
32	16.510	-0.542	0.019	0.345	0.809

33	16.321	0.373	-1.258	-1.909	-0.644
34	16.017	-0.538	-1.296	-1.947	0.803
35	17.279	0.045	1.568	3.027	-0.126
36	17.187	-0.229	1.557	3.016	0.310
37	15.551	-0.215	-2.808	-4.592	0.290
38	15.643	0.060	-2.796	-4.580	-0.146

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	40.336	-0.228	-1.439	-1.828	0.223
40	38.090	0.439	-0.400	-0.068	-0.825
41	37.657	-0.857	-0.454	-0.123	1.235
42	37.387	0.445	-2.274	-3.335	-0.833
43	36.954	-0.851	-2.329	-3.390	1.226
44	38.751	-0.021	1.750	3.692	-0.096
45	38.620	-0.412	1.733	3.676	0.526
46	36.423	-0.000	-4.462	-7.134	-0.124
47	36.292	-0.391	-4.478	-7.150	0.498
48	25.191	0.518	0.035	0.488	-0.902
49	24.758	-0.778	-0.020	0.433	1.157
50	24.488	0.524	-1.840	-2.779	-0.911
51	24.055	-0.772	-1.894	-2.834	1.149
52	25.852	0.058	2.184	4.248	-0.174
53	25.722	-0.333	2.168	4.232	0.448
54	23.524	0.079	-4.027	-6.578	-0.202
55	23.394	-0.312	-4.044	-6.594	0.420

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.253 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.800 m Governing Load Case : # 26

Width (W_2) = 0.800 m Governing Load Case : # 26

Depth (D_2) = 0.350 m Governing Load Case : # 41

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

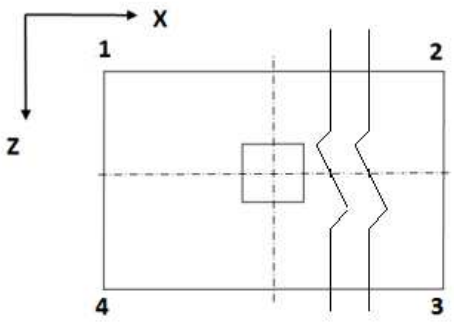
Area (A_2) = 0.640 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 5.376 kN

Soil Weight On Top Of Footing = 5.738 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
30	**130.9883**	121.3296	-1.7908	7.8680	0.000
29	126.3155	**125.9428**	3.0955	3.4682	0.000
35	0.7884	4.1155	**87.9387**	84.6116	0.000
36	7.0634	-2.0794	81.3771	**90.5199**	0.001

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

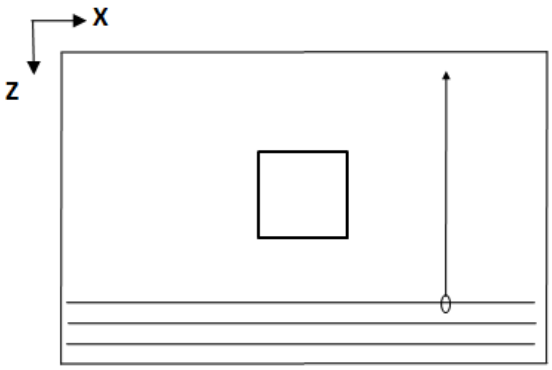
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**130.9902**	121.3313	0.0000	7.8644
29	126.3155	**125.9428**	3.0955	3.4682
35	0.7884	4.1155	**87.9387**	84.6116
36	7.0603	0.0000	81.3839	**90.5291**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 41

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.270	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.340	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	4.119	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	4.577	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00019	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00014	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	504.001	mm2

Selected bar Size = #10

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 106.667mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#10 @ 105.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=1.424	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.265	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	7	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	549.792	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00255	

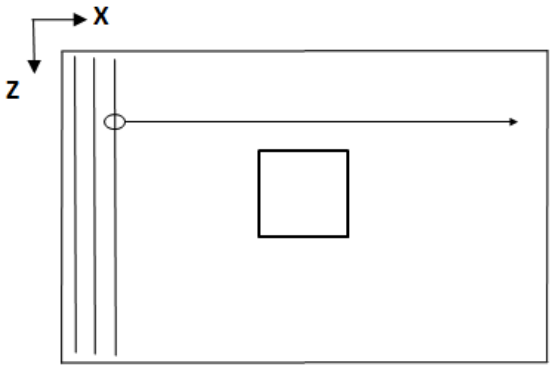
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.260	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.250	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	3.873	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	4.304	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00019	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00014	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	504.001	mm2

Selected Bar Size = #10

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 106.667mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#10 @ 105.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	1.424	m

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.175 m

Try bar size # 10 Area of one bar = 78.542 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 7

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 549.792 mm2

d_{eff} = D - C_{cover} - 1.5 X (dia. of one bar) = 0.260 m

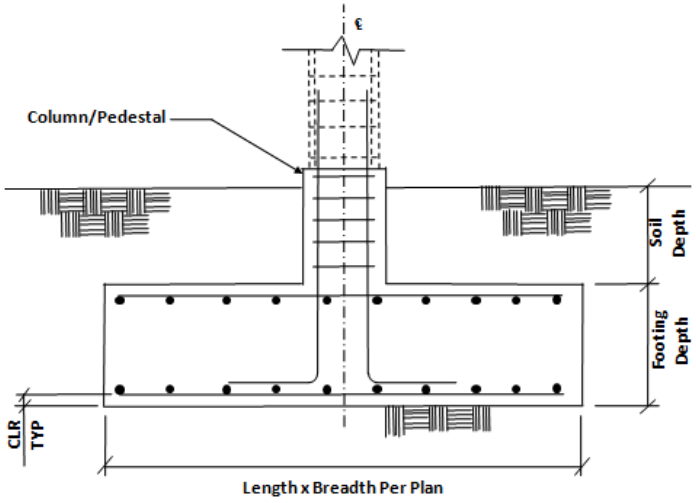
Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00264

From ACI Cl.7.6.1, minimum req'd clear distance between bars

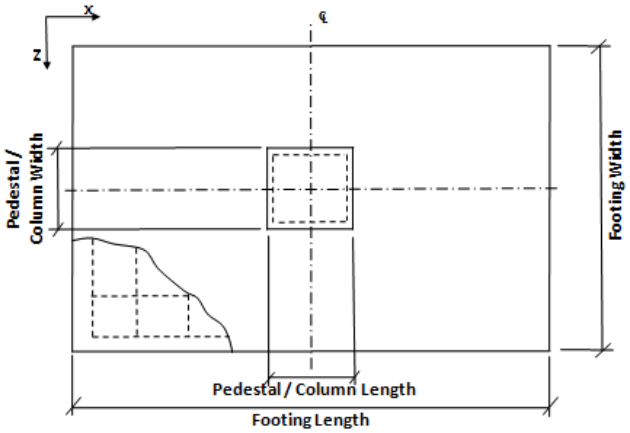
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 63



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	22.818	-0.541	-0.514	-0.840	0.396
23	22.333	1.136	-0.063	0.052	-2.572
24	21.838	-2.117	-0.052	0.065	3.218
25	22.968	1.067	-0.954	-1.704	-2.447
26	22.472	-2.186	-0.943	-1.690	3.342
27	21.416	0.078	0.984	2.113	-0.689
28	21.268	-0.896	0.988	2.117	1.043
29	23.537	-0.154	-1.994	-3.756	-0.272
30	23.389	-1.128	-1.991	-3.752	1.459
31	12.598	1.929	0.308	0.716	-3.731
32	11.937	-2.409	0.323	0.735	3.988

33	13.450	1.835	-0.889	-1.641	-3.564
34	12.789	-2.502	-0.874	-1.623	4.155
35	11.379	0.521	1.700	3.457	-1.228
36	11.180	-0.786	1.705	3.462	1.097
37	14.008	-1.095	-2.266	-4.363	1.653
38	14.207	0.212	-2.271	-4.369	-0.673

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	28.047	-0.674	-0.633	-1.042	0.492
40	26.913	2.517	0.234	0.676	-5.145
41	25.972	-3.656	0.255	0.702	5.840
42	28.127	2.384	-1.471	-2.685	-4.907
43	27.186	-3.789	-1.450	-2.659	6.078
44	25.180	0.515	2.214	4.573	-1.586
45	24.896	-1.348	2.221	4.580	1.729
46	29.203	0.075	-3.437	-6.563	-0.796
47	28.919	-1.788	-3.430	-6.556	2.519
48	18.903	2.722	0.418	0.987	-5.294
49	17.963	-3.450	0.439	1.013	5.691
50	20.118	2.590	-1.288	-2.373	-5.055
51	19.177	-3.583	-1.267	-2.348	5.930
52	17.170	0.721	2.398	4.884	-1.735
53	16.886	-1.142	2.404	4.892	1.581
54	21.194	0.281	-3.253	-6.252	-0.944
55	20.910	-1.582	-3.247	-6.244	2.371

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.191 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 34

Width (W_2) = 0.900 m Governing Load Case : # 34

Depth (D_2) = 0.350 m Governing Load Case : # 46

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

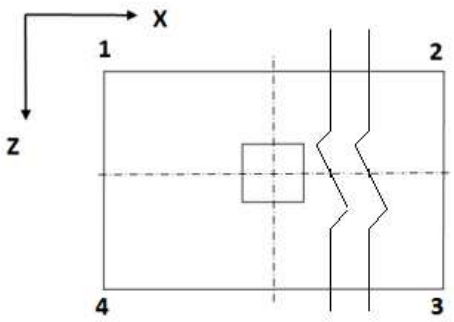
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
37	**93.6558**	60.1445	-24.7362	8.7750	0.088
33	15.2187	**84.4597**	52.3237	-16.9173	0.052
35	-13.7451	9.4794	**76.1747**	52.9502	0.049
32	64.6920	-14.8359	-0.8852	**78.6426**	0.080

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

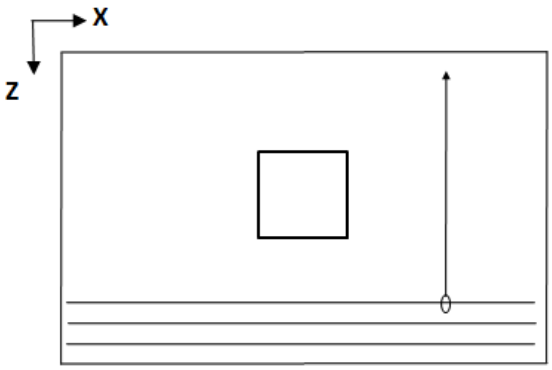
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
37	**98.0251**	59.0014	0.0000	0.0000
33	13.4661	**85.7652**	51.2152	0.0000
35	0.0000	8.7970	**77.5769**	52.7628
32	65.5951	0.0000	0.0000	**81.2703**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 43

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	4.610	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.122	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00019	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00014	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = $\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ = =0.305 m

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.250 m

Try bar size # 16 Area of one bar = 201.064 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 3

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 603.192 mm2

d_{eff} = D - C_{cover} - 0.5 X (dia. of one bar) = 0.267 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00251

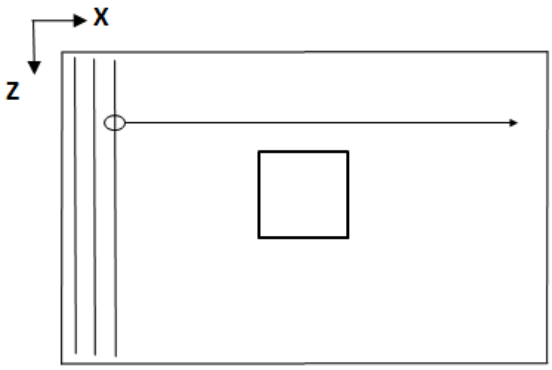
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 46

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	4.836	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.373	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00021	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00016	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

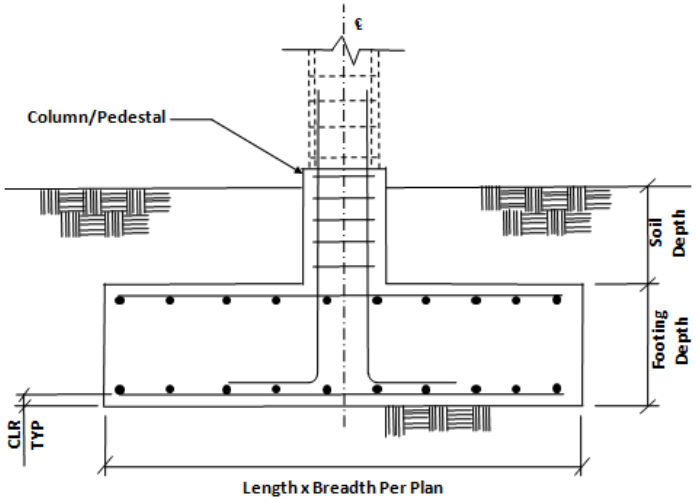
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

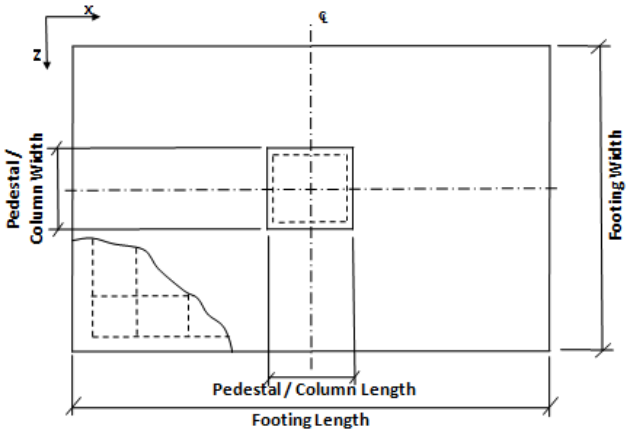
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 64



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	26.022	0.381	-0.450	-0.660	-0.572
23	24.901	1.989	-0.056	0.113	-3.465
24	25.508	-1.180	-0.018	0.192	2.233
25	25.526	1.919	-0.868	-1.485	-3.340
26	26.133	-1.250	-0.830	-1.406	2.358
27	24.381	0.960	0.908	2.013	-1.614
28	24.563	0.012	0.919	2.036	0.091
29	26.471	0.726	-1.805	-3.329	-1.198
30	26.653	-0.222	-1.794	-3.306	0.507
31	13.577	2.359	0.266	0.656	-4.181
32	14.386	-1.866	0.317	0.761	3.416

33	14.416	2.265	-0.824	-1.490	-4.014
34	15.225	-1.960	-0.773	-1.385	3.583
35	12.886	0.992	1.548	3.181	-1.721
36	13.130	-0.280	1.563	3.213	0.568
37	15.916	-0.593	-2.054	-3.910	1.123
38	15.673	0.680	-2.070	-3.942	-1.166

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	32.035	0.477	-0.551	-0.812	-0.716
40	29.649	3.521	0.206	0.674	-6.196
41	30.800	-2.491	0.278	0.823	4.615
42	30.846	3.387	-1.347	-2.385	-5.958
43	31.997	-2.625	-1.275	-2.236	4.853
44	28.666	1.577	2.029	4.265	-2.698
45	29.014	-0.237	2.051	4.310	0.565
46	32.632	1.133	-3.119	-5.872	-1.908
47	32.979	-0.682	-3.098	-5.827	1.355
48	20.428	3.373	0.361	0.908	-5.973
49	21.579	-2.639	0.433	1.057	4.838
50	21.624	3.239	-1.193	-2.151	-5.735
51	22.776	-2.774	-1.121	-2.002	5.076
52	19.445	1.429	2.183	4.499	-2.474
53	19.792	-0.385	2.205	4.544	0.788
54	23.411	0.985	-2.965	-5.637	-1.685
55	23.758	-0.830	-2.943	-5.592	1.578

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.213 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 33

Width (W_2) = 0.900 m Governing Load Case : # 33

Depth (D_2) = 0.350 m Governing Load Case : # 47

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

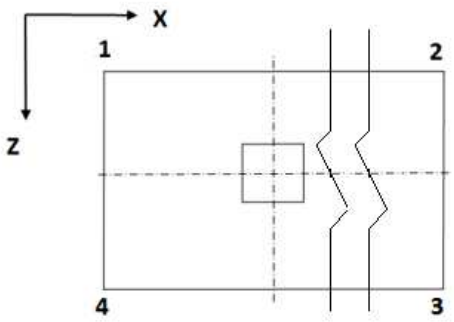
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
30	**87.2575**	77.6379	12.8850	22.5046	0.000
25	30.3829	**96.4209**	66.9782	0.9402	0.000
23	12.8941	81.3841	**82.9233**	14.4333	0.000
32	61.2414	-5.7412	8.6116	**75.5942**	0.014

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

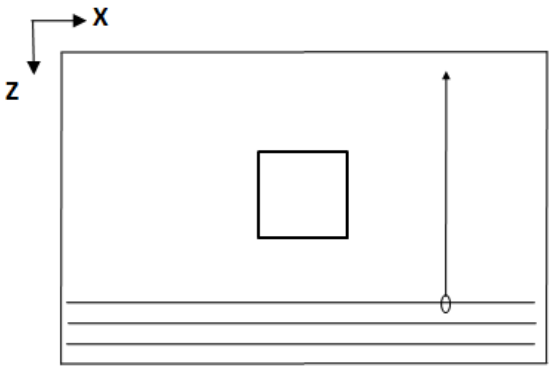
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**87.2575**	77.6379	12.8850	22.5046
25	30.3829	**96.4209**	66.9782	0.9402
23	12.8941	81.3841	**82.9233**	14.4333
32	61.2780	0.0000	8.6062	**75.7968**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 42

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	5.003	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.558	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00020	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00016	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.267	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00251	

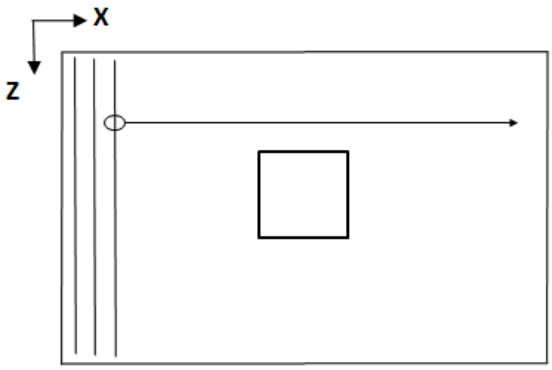
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	4.803	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.337	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00021	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00016	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

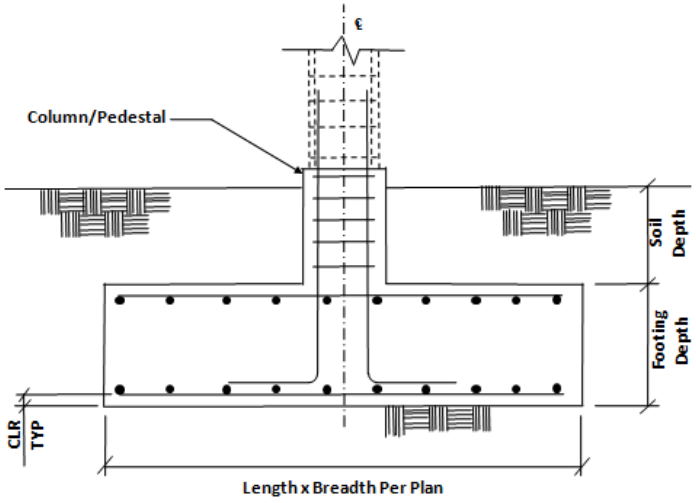
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

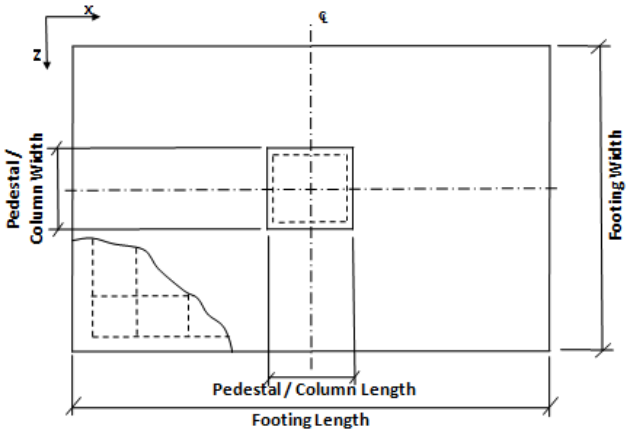
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 65



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	36.424	0.446	-0.583	-0.802	-0.581
23	34.576	2.176	-0.077	0.090	-3.750
24	35.917	-1.336	-0.028	0.180	2.656
25	34.296	2.187	-1.117	-1.750	-3.768
26	35.637	-1.325	-1.068	-1.659	2.638
27	35.374	0.934	1.159	2.277	-1.484
28	35.776	-0.117	1.173	2.304	0.432
29	34.437	0.968	-2.318	-3.873	-1.544
30	34.839	-0.083	-2.303	-3.846	0.372
31	17.985	2.553	0.342	0.735	-4.546
32	19.774	-2.129	0.407	0.856	3.995

33	17.609	2.567	-1.055	-1.735	-4.570
34	19.398	-2.116	-0.989	-1.615	3.971
35	19.047	0.901	1.984	3.642	-1.534
36	19.586	-0.510	2.004	3.678	1.039
37	18.337	-0.464	-2.632	-4.521	0.959
38	17.798	0.947	-2.651	-4.558	-1.614

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	45.818	0.567	-0.718	-0.990	-0.739
40	41.650	3.841	0.258	0.727	-6.737
41	44.196	-2.823	0.351	0.898	5.417
42	41.114	3.861	-1.733	-2.795	-6.771
43	43.660	-2.803	-1.640	-2.624	5.383
44	43.160	1.492	2.593	4.860	-2.455
45	43.928	-0.520	2.621	4.912	1.214
46	41.382	1.557	-4.004	-6.808	-2.568
47	42.150	-0.454	-3.976	-6.757	1.100
48	27.033	3.650	0.464	1.016	-6.491
49	29.579	-3.014	0.556	1.187	5.663
50	26.496	3.670	-1.527	-2.506	-6.525
51	29.042	-2.994	-1.435	-2.335	5.629
52	28.542	1.301	2.799	5.149	-2.208
53	29.311	-0.710	2.827	5.200	1.460
54	26.765	1.367	-3.798	-6.520	-2.322
55	27.533	-0.645	-3.770	-6.468	1.346

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.281 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 25

Width (W_2) = 0.900 m Governing Load Case : # 25

Depth (D_2) = 0.350 m Governing Load Case : # 47

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

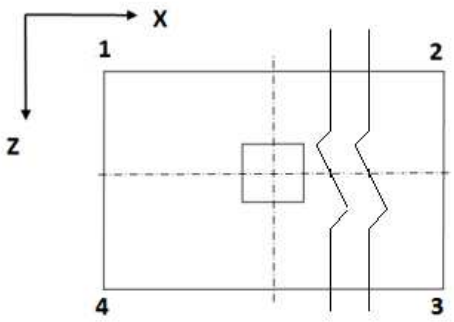
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
26	**103.4270**	52.3655	18.8987	69.9602	0.000
25	39.8148	**114.4316**	79.1983	4.5815	0.000
27	23.8579	53.6657	**97.8187**	68.0108	0.000
32	72.3802	-5.6518	10.7780	**88.8100**	0.009

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

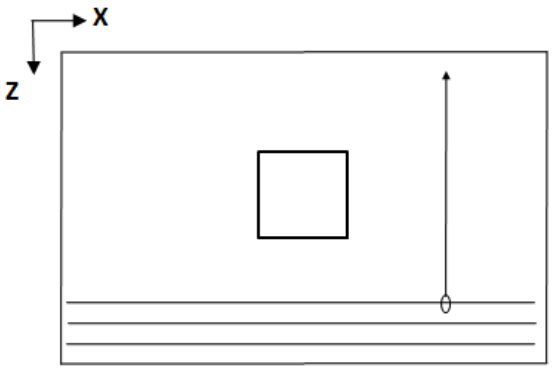
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**103.4270**	52.3655	18.8987	69.9602
25	39.8148	**114.4316**	79.1983	4.5815
27	23.8579	53.6657	**97.8187**	68.0108
32	72.4076	0.0000	10.7756	**88.9545**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 42

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	5.830	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	6.477	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00024	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00018	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = $\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ = =0.305 m

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.250 m

Try bar size # 16 Area of one bar = 201.064 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 3

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 603.192 mm2

d_{eff} = D - C_{cover} - 0.5 X (dia. of one bar) = 0.267 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00251

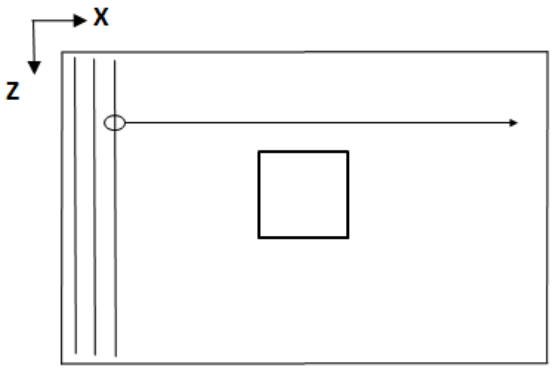
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	5.709	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	6.343	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00025	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00018	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

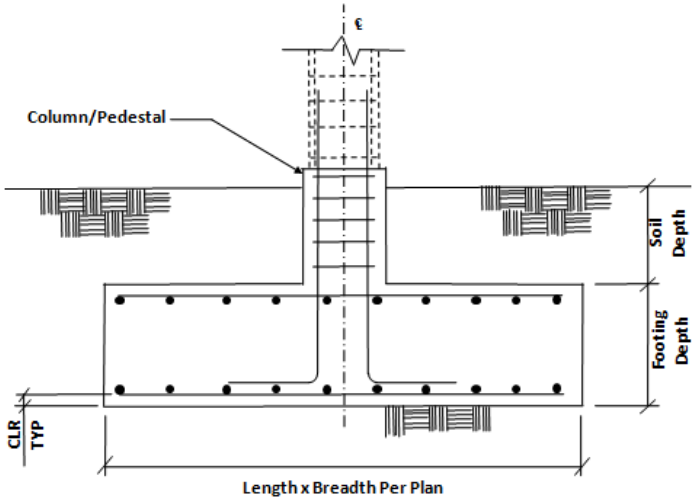
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

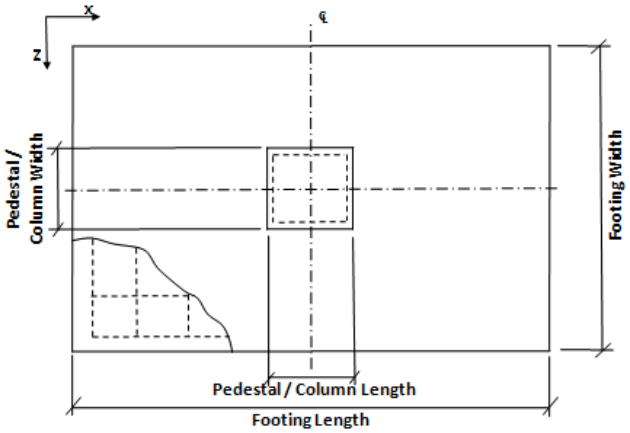
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 66



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	28.468	0.668	0.739	0.592	-0.681
23	26.944	2.218	1.095	1.326	-3.542
24	28.044	-1.019	1.142	1.413	2.356
25	26.664	2.296	0.330	-0.223	-3.657
26	27.764	-0.941	0.377	-0.135	2.242
27	27.657	0.992	2.008	3.170	-1.341
28	27.986	0.024	2.022	3.197	0.424
29	26.722	1.252	-0.550	-2.007	-1.724
30	27.051	0.284	-0.536	-1.980	0.041
31	13.861	2.435	0.919	1.343	-4.189
32	15.328	-1.881	0.981	1.460	3.675

33	13.485	2.539	-0.108	-0.737	-4.343
34	14.952	-1.776	-0.046	-0.620	3.521
35	14.809	0.806	2.132	3.795	-1.263
36	15.251	-0.494	2.150	3.831	1.106
37	14.004	-0.148	-1.259	-3.072	0.595
38	13.562	1.153	-1.278	-3.107	-1.774

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	35.945	0.850	0.891	0.707	-0.867
40	32.495	3.774	1.572	2.112	-6.279
41	34.582	-2.367	1.661	2.279	4.913
42	31.959	3.923	0.108	-0.852	-6.498
43	34.046	-2.218	0.196	-0.686	4.694
44	33.843	1.458	3.297	5.599	-2.118
45	34.473	-0.396	3.324	5.650	1.260
46	32.068	1.951	-1.555	-4.224	-2.845
47	32.698	0.098	-1.528	-4.173	0.533
48	20.834	3.490	1.342	1.942	-5.987
49	22.921	-2.652	1.431	2.108	5.205
50	20.299	3.639	-0.122	-1.023	-6.206
51	22.386	-2.503	-0.033	-0.857	4.985
52	22.183	1.174	3.067	5.429	-1.826
53	22.812	-0.680	3.094	5.479	1.551
54	20.408	1.667	-1.785	-4.394	-2.553
55	21.037	-0.186	-1.758	-4.344	0.825

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.226m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 33

Width (W_2) = 0.900 m Governing Load Case : # 33

Depth (D_2) = 0.350 m Governing Load Case : # 45

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

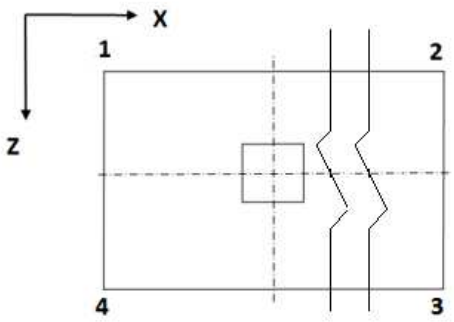
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
34	**74.9595**	6.7585	-3.7080	64.4930	0.008
25	14.2623	**87.6781**	85.9077	12.4919	0.000
23	0.8249	71.9062	**100.0361**	28.9548	0.000
24	59.1975	14.5377	44.3795	**89.0393**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

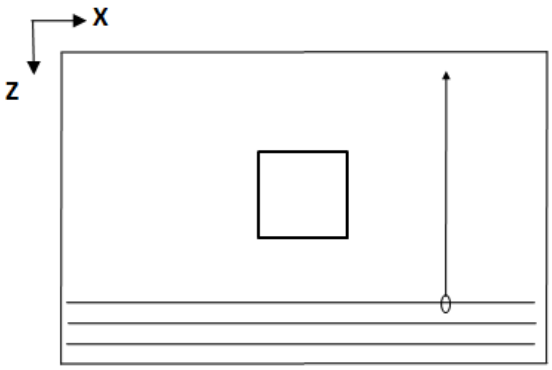
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**75.0169**	0.0000	0.0000	64.4900
25	14.2623	**87.6781**	85.9077	12.4919
23	0.8249	71.9062	**100.0361**	28.9548
24	59.1975	14.5377	44.3795	**89.0393**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 40

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	5.242	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.824	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00021	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00016	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.267	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00251	

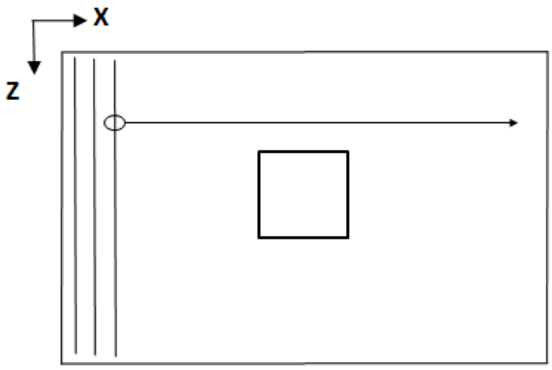
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 44

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	4.902	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.446	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00021	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00016	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

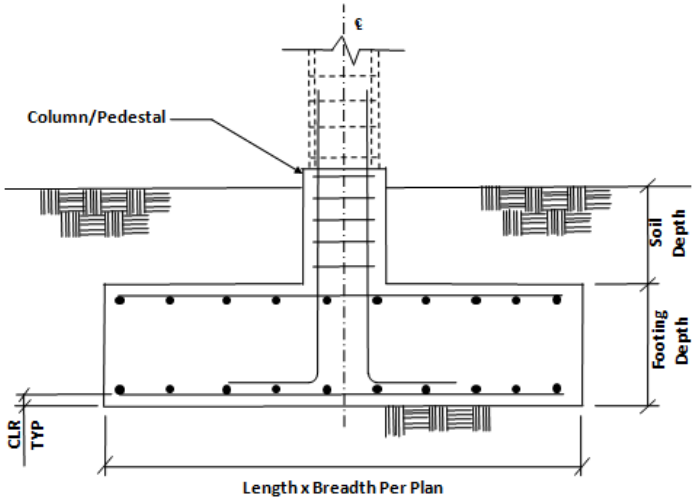
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

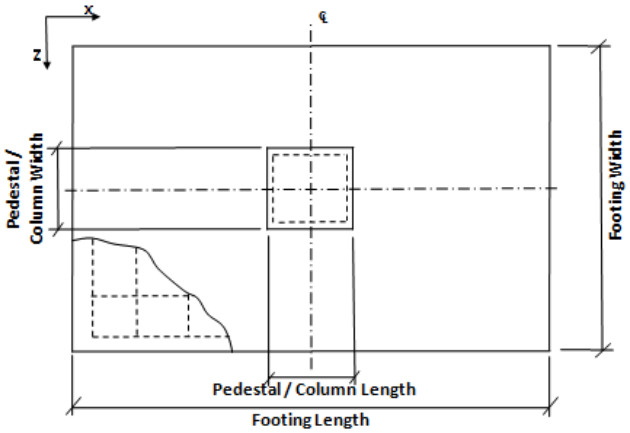
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 67



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	15.052	1.324	0.640	0.599	-1.370
23	15.670	2.559	0.886	1.116	-3.898
24	13.928	-0.088	1.053	1.454	1.375
25	15.352	2.589	0.226	-0.254	-3.962
26	13.610	-0.058	0.394	0.084	1.311
27	15.432	1.596	1.717	2.839	-1.975
28	14.911	0.804	1.767	2.940	-0.398
29	14.369	1.697	-0.487	-1.740	-2.190
30	13.848	0.905	-0.437	-1.639	-0.612
31	9.417	2.364	0.714	1.057	-4.111
32	7.095	-1.165	0.938	1.507	2.919

33	8.990	2.405	-0.171	-0.783	-4.197
34	6.667	-1.125	0.053	-0.332	2.833
35	9.101	1.084	1.819	3.347	-1.555
36	8.401	0.021	1.887	3.483	0.563
37	6.983	0.155	-1.052	-2.623	0.277
38	7.683	1.219	-1.119	-2.758	-1.841

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	18.722	1.705	0.768	0.717	-1.766
40	19.689	4.012	1.240	1.710	-6.523
41	16.385	-1.010	1.558	2.352	3.481
42	19.081	4.070	-0.022	-0.912	-6.646
43	15.776	-0.952	0.296	-0.271	3.358
44	19.240	2.192	2.810	4.967	-2.889
45	18.243	0.676	2.907	5.161	0.131
46	17.223	2.384	-1.371	-3.721	-3.296
47	16.225	0.868	-1.275	-3.528	-0.277
48	14.020	3.412	1.047	1.534	-5.899
49	10.715	-1.611	1.366	2.175	4.105
50	13.411	3.470	-0.215	-1.088	-6.022
51	10.106	-1.553	0.104	-0.447	3.982
52	13.571	1.591	2.618	4.791	-2.264
53	12.573	0.076	2.714	4.984	0.755
54	11.553	1.783	-1.563	-3.898	-2.672
55	10.556	0.267	-1.467	-3.704	0.347

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.137 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 31

Width (W_2) = 0.900 m Governing Load Case : # 31

Depth (D_2) = 0.350 m Governing Load Case : # 45

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

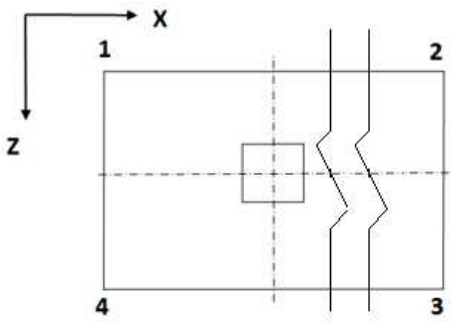
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
34	**54.5355**	1.4230	-3.7398	49.3727	0.021
33	-6.2733	**76.6720**	62.8023	-20.1429	0.127
23	-14.6787	64.2271	**87.7022**	8.7964	0.048
32	38.2004	-16.5667	13.6501	**68.4171**	0.067

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

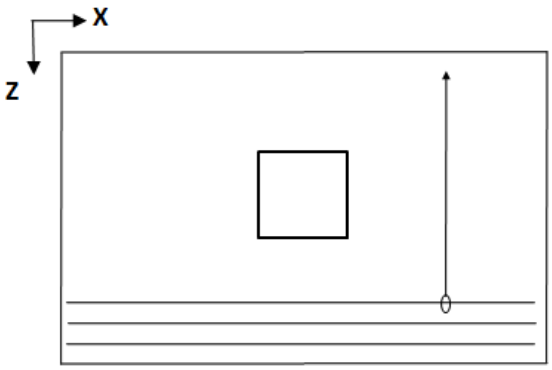
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**54.6863**	0.0000	0.0000	49.3862
33	0.0000	**80.6252**	62.3519	0.0000
23	0.0000	63.9542	**88.9534**	7.8001
32	38.5429	0.0000	13.5352	**71.2973**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 42

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	5.399	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.998	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00022	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00017	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.267	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00251	

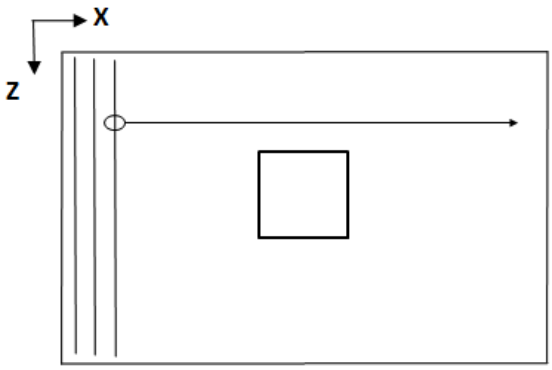
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 44

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	4.333	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	4.815	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00019	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00014	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.250 m

Try bar size # 16 Area of one bar = 201.064 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 3

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 603.192 mm2

d_{eff} = D - C_{cover} - 1.5 X (dia. of one bar) = 0.251 m

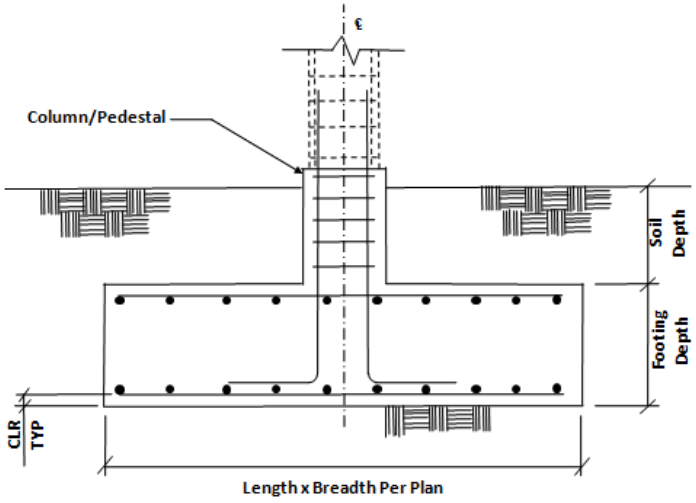
Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00267

From ACI Cl.7.6.1, minimum req'd clear distance between bars

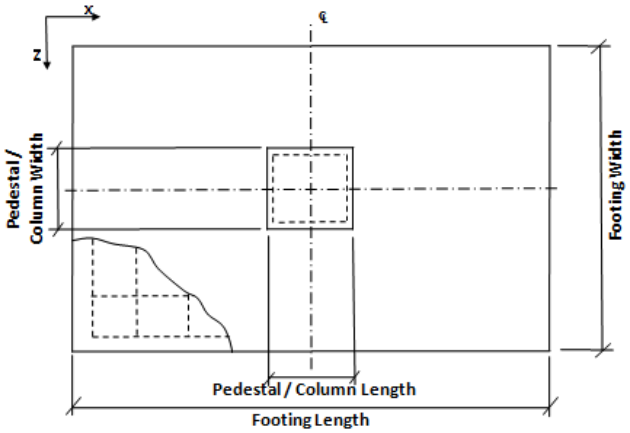
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 68



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	20.787	1.922	-0.365	-0.461	-2.136
23	21.319	3.283	-0.004	0.178	-4.911
24	19.424	0.367	0.225	0.581	0.860
25	21.085	3.292	-0.949	-1.495	-4.927
26	19.190	0.376	-0.721	-1.092	0.843
27	20.930	2.250	1.184	2.279	-2.870
28	20.363	1.378	1.253	2.399	-1.143
29	20.146	2.281	-1.977	-3.313	-2.924
30	19.579	1.408	-1.909	-3.192	-1.198
31	12.614	2.868	0.269	0.587	-4.872
32	10.087	-1.020	0.574	1.125	2.822

33	12.299	2.880	-1.001	-1.659	-4.894
34	9.773	-1.008	-0.696	-1.122	2.800
35	12.096	1.496	1.848	3.379	-2.159
36	11.335	0.324	1.940	3.541	0.159
37	10.290	0.364	-2.275	-3.914	0.087
38	11.052	1.536	-2.367	-4.076	-2.231

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	25.798	2.456	-0.441	-0.559	-2.727
40	26.541	4.991	0.253	0.669	-7.941
41	22.945	-0.543	0.687	1.434	3.009
42	26.092	5.008	-1.558	-2.533	-7.972
43	22.496	-0.526	-1.124	-1.768	2.977
44	25.804	3.039	2.498	4.640	-4.082
45	24.719	1.369	2.629	4.870	-0.778
46	24.318	3.096	-3.500	-5.970	-4.186
47	23.233	1.426	-3.369	-5.739	-0.881
48	18.812	4.153	0.368	0.817	-7.013
49	15.217	-1.381	0.802	1.582	3.936
50	18.363	4.170	-1.442	-2.385	-7.044
51	14.768	-1.363	-1.008	-1.620	3.905
52	18.076	2.201	2.614	4.788	-3.155
53	16.991	0.531	2.745	5.019	0.150
54	16.589	2.259	-3.384	-5.821	-3.258
55	15.504	0.589	-3.253	-5.591	0.046

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.176m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 1.000 m Governing Load Case : # 38

Width (W_2) = 1.000 m Governing Load Case : # 38

Depth (D_2) = 0.350 m Governing Load Case : # 46

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

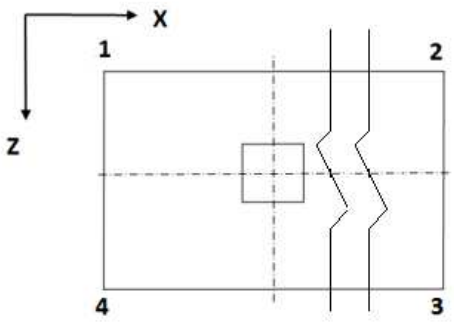
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.906 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
37	**55.6129**	56.1033	-0.4209	-0.9113	0.000
25	12.8766	**85.8310**	63.9041	-9.0502	0.026
27	0.1330	44.0214	**76.3376**	32.4493	0.000
32	38.5146	0.3654	16.2715	**54.4207**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

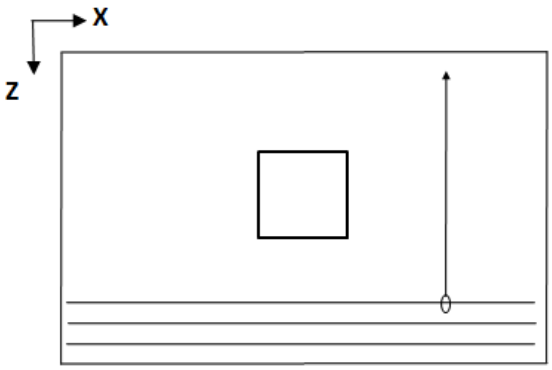
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
37	**55.6226**	56.1130	0.0000	0.0000
25	12.5407	**86.0668**	63.6934	0.0000
27	0.1330	44.0214	**76.3376**	32.4493
32	38.5146	0.3654	16.2715	**54.4207**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 42

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.269	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	6.928	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	7.698	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00025	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00019	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected bar Size = #12

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 12	Area of one bar =	113.097	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.269	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

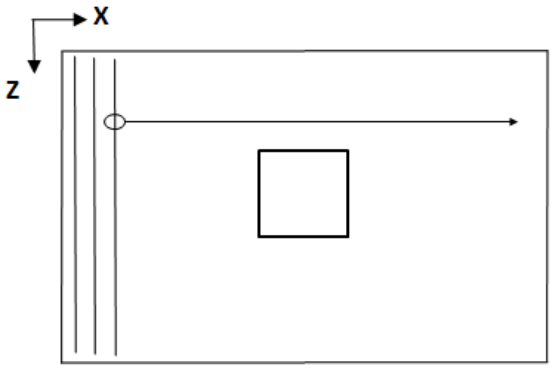
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 46

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.257	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	5.203	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.781	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00020	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00015	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected Bar Size = #12

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	0.305	m

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.300	m	
Try bar size # 12	Area of one bar =	113.097	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

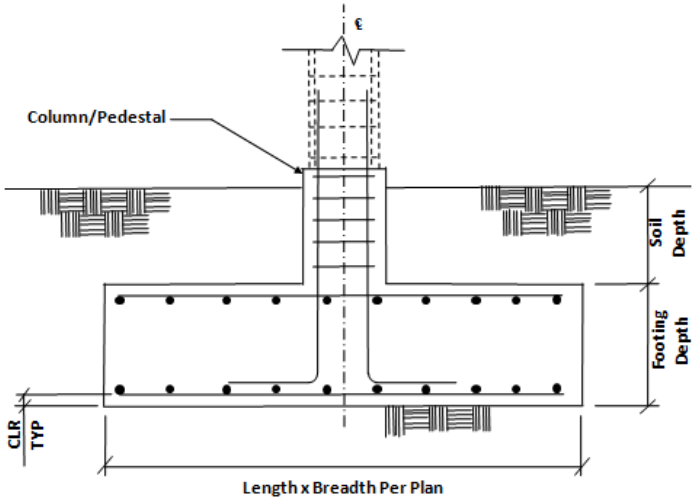
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

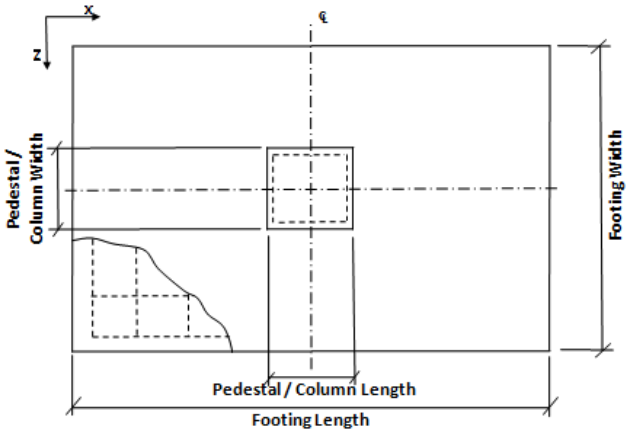
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 69



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	14.499	1.635	-0.332	-0.425	-1.892
23	14.936	2.856	-0.055	0.123	-4.375
24	13.126	0.376	0.130	0.482	0.592
25	15.466	2.799	-0.790	-1.326	-4.265
26	13.655	0.319	-0.604	-0.967	0.702
27	13.681	2.054	0.870	1.947	-2.764
28	13.140	1.312	0.925	2.054	-1.278
29	15.452	1.863	-1.585	-2.898	-2.395
30	14.910	1.121	-1.530	-2.790	-0.909
31	9.063	2.559	0.174	0.486	-4.387
32	6.648	-0.747	0.422	0.965	2.235

33	9.774	2.482	-0.812	-1.460	-4.239
34	7.360	-0.824	-0.564	-0.982	2.383
35	7.394	1.493	1.404	2.910	-2.246
36	6.667	0.496	1.479	3.054	-0.250
37	9.028	0.242	-1.794	-3.405	0.242
38	9.755	1.238	-1.869	-3.549	-1.754

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	17.725	2.037	-0.401	-0.515	-2.359
40	18.447	4.331	0.130	0.539	-7.044
41	15.011	-0.374	0.483	1.220	2.381
42	19.461	4.222	-1.276	-2.235	-6.833
43	16.025	-0.483	-0.923	-1.554	2.592
44	16.075	2.815	1.879	3.986	-3.998
45	15.038	1.395	1.986	4.191	-1.154
46	19.434	2.453	-2.779	-5.206	-3.298
47	18.398	1.033	-2.672	-5.001	-0.454
48	13.527	3.708	0.234	0.675	-6.321
49	10.092	-0.997	0.587	1.356	3.104
50	14.541	3.599	-1.171	-2.099	-6.110
51	11.106	-1.106	-0.819	-1.418	3.315
52	11.155	2.192	1.983	4.122	-3.275
53	10.118	0.772	2.090	4.327	-0.431
54	14.515	1.830	-2.674	-5.070	-2.575
55	13.478	0.410	-2.568	-4.865	0.269

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.135 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 25

Width (W_2) = 0.900 m Governing Load Case : # 25

Depth (D_2) = 0.350 m Governing Load Case : # 46

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

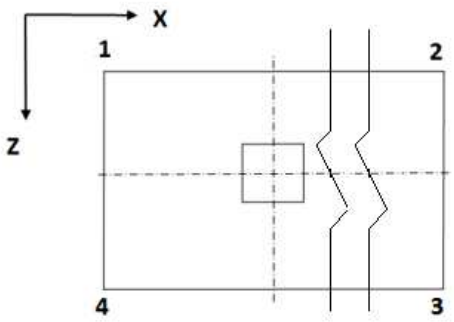
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
37	**62.7976**	60.2166	-6.1738	-3.5929	0.060
25	6.2819	**92.6121**	66.2379	-20.0923	0.071
35	-24.4828	21.0811	**77.0733**	31.5094	0.096
32	36.7714	-4.3307	13.9773	**55.0793**	0.010

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

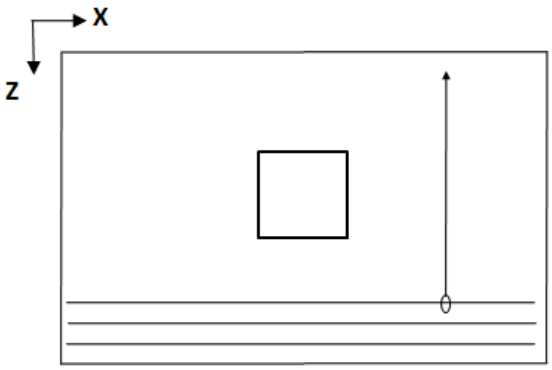
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
37	**63.1862**	60.3503	0.0000	0.0000
25	0.0000	**94.7887**	64.8505	0.0000
35	0.0000	18.5745	**82.6285**	29.3648
32	36.7867	0.0000	13.9814	**55.1961**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 40

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	5.815	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	6.461	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00024	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00018	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = $\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ = =0.305 m

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.250 m

Try bar size # 16 Area of one bar = 201.064 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 3

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 603.192 mm2

d_{eff} = D - C_{cover} - 0.5 X (dia. of one bar) = 0.267 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00251

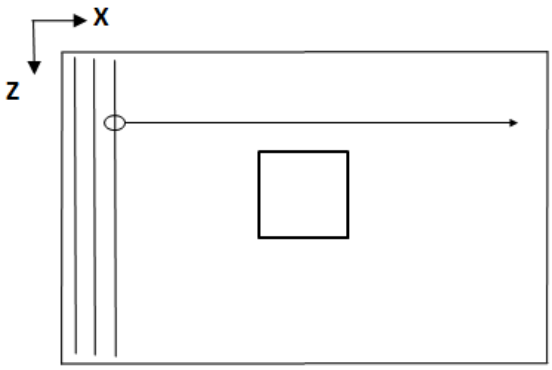
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 44

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	3.869	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	4.299	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00017	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00013	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m	
Try bar size # 16	Area of one bar =	201.064	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

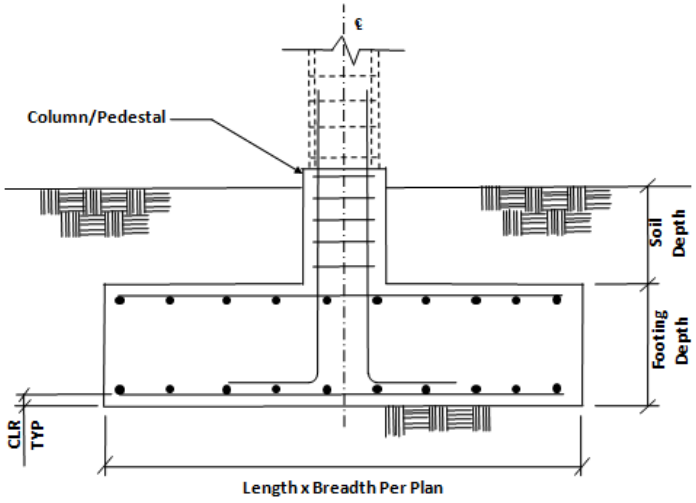
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

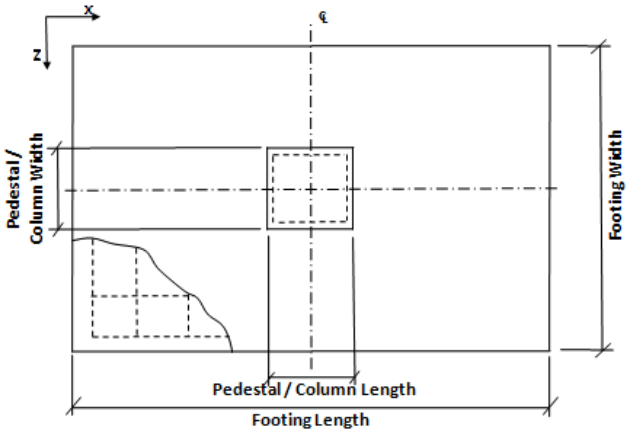
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 70



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) = 0.500m

Initial Width (W_o) = 0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	29.763	2.633	-0.451	-0.686	-2.966
23	28.439	4.127	0.035	0.267	-5.741
24	29.194	1.058	-0.046	0.104	-0.144
25	29.119	4.056	-0.842	-1.451	-5.614
26	29.874	0.986	-0.923	-1.615	-0.016
27	27.906	3.135	1.034	2.223	-3.929
28	28.132	2.217	1.010	2.174	-2.255
29	30.181	2.897	-1.898	-3.522	-3.503
30	30.407	1.978	-1.922	-3.571	-1.828
31	15.442	3.490	0.389	0.881	-5.388
32	16.448	-0.602	0.282	0.663	2.075

33	16.356	3.395	-0.788	-1.427	-5.217
34	17.362	-0.698	-0.896	-1.645	2.247
35	14.733	2.172	1.717	3.481	-2.979
36	15.037	0.939	1.685	3.415	-0.731
37	18.070	0.621	-2.224	-4.245	-0.162
38	17.767	1.854	-2.191	-4.179	-2.411

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	36.686	3.283	-0.553	-0.843	-3.698
40	33.863	6.079	0.380	0.987	-8.922
41	35.295	0.255	0.227	0.677	1.699
42	35.166	5.943	-1.298	-2.303	-8.678
43	36.598	0.118	-1.452	-2.613	1.943
44	32.856	4.204	2.269	4.684	-5.497
45	33.288	2.446	2.222	4.590	-2.292
46	37.173	3.752	-3.294	-6.217	-4.688
47	37.605	1.994	-3.340	-6.311	-1.482
48	23.235	5.075	0.536	1.227	-7.789
49	24.668	-0.750	0.383	0.917	2.832
50	24.538	4.938	-1.143	-2.063	-7.544
51	25.971	-0.886	-1.296	-2.373	3.076
52	22.228	3.199	2.424	4.924	-4.363
53	22.660	1.442	2.378	4.830	-1.158
54	26.545	2.747	-3.138	-5.977	-3.554
55	26.978	0.989	-3.184	-6.071	-0.349

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.239 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 23

Width (W_2) = 0.900 m Governing Load Case : # 23

Depth (D_2) = 0.350 m Governing Load Case : # 47

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

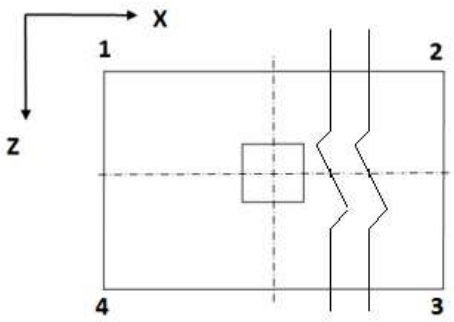
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
37	**77.6988**	83.9437	1.2521	-4.9928	0.017
29	51.7043	**126.0553**	57.1499	-17.2011	0.023
27	-11.0319	71.7137	**114.2683**	31.5227	0.016
32	50.0220	12.3912	24.9236	**62.5545**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

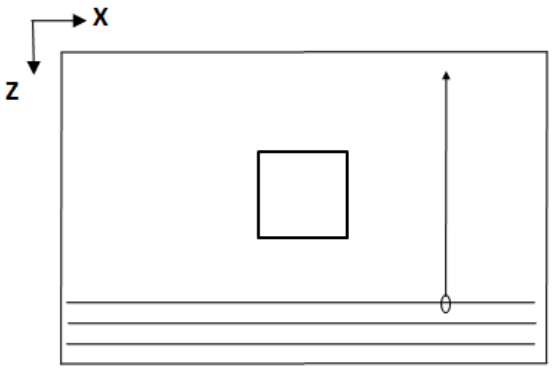
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
37	**77.6454**	84.0474	0.0000	0.0000
29	51.1097	**126.5701**	56.5699	0.0000
27	0.0000	71.6334	**114.5626**	31.4007
32	50.0220	12.3912	24.9236	**62.5545**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 40

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	7.302	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.113	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00030	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00023	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = $\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ = =0.305 m

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.250 m

Try bar size # 16 Area of one bar = 201.064 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 3

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 603.192 mm2

d_{eff} = D - C_{cover} - 0.5 X (dia. of one bar) = 0.267 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00251

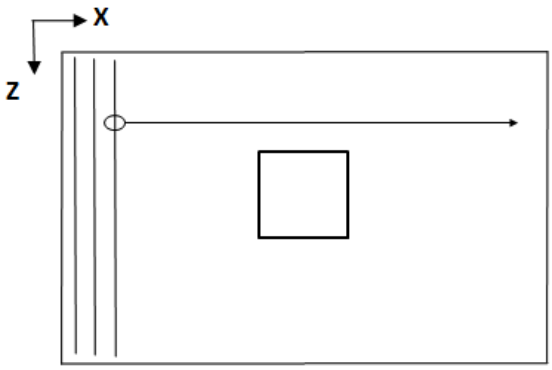
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	5.244	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.826	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00023	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00017	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m	
Try bar size # 16	Area of one bar =	201.064	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

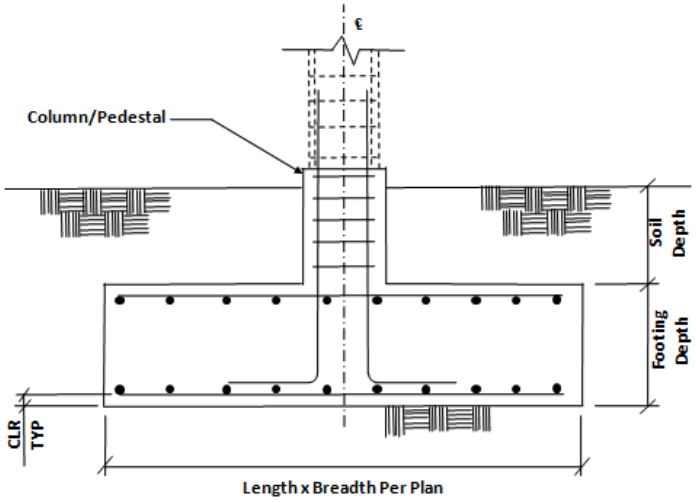
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

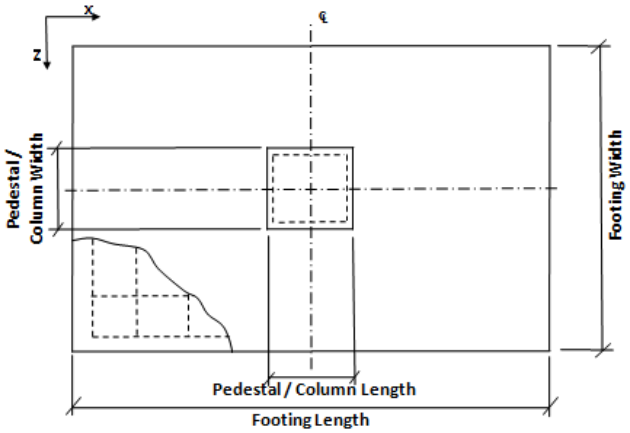
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 71



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	28.744	-5.460	-1.124	-1.392	5.616
23	27.652	-3.925	-0.548	-0.384	2.653
24	28.486	-6.458	-0.801	-0.811	8.027
25	27.220	-3.927	-1.423	-1.941	2.654
26	28.055	-6.460	-1.676	-2.369	8.028
27	28.449	-4.811	0.389	1.292	4.534
28	28.699	-5.569	0.313	1.164	6.142
29	27.007	-4.817	-2.537	-3.916	4.539
30	27.257	-5.575	-2.613	-4.044	6.146
31	14.841	-0.946	0.112	0.533	-0.876
32	15.954	-4.323	-0.226	-0.037	6.290

33	14.262	-0.948	-1.063	-1.559	-0.874
34	15.375	-4.325	-1.401	-2.129	6.292
35	15.902	-2.123	1.357	2.760	1.625
36	16.237	-3.140	1.255	2.588	3.784
37	14.315	-3.148	-2.646	-4.355	3.790
38	13.979	-2.131	-2.544	-4.184	1.631

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	35.918	-6.978	-1.369	-1.695	7.181
40	33.401	-3.933	-0.261	0.239	1.419
41	34.985	-8.739	-0.741	-0.572	11.616
42	32.575	-3.937	-1.937	-2.743	1.421
43	34.159	-8.743	-2.417	-3.555	11.619
44	34.909	-5.607	1.509	3.405	4.976
45	35.387	-7.058	1.364	3.161	8.054
46	32.173	-5.618	-4.042	-6.476	4.984
47	32.651	-7.069	-4.187	-6.721	8.062
48	22.283	-1.548	0.111	0.700	-1.038
49	23.867	-6.354	-0.369	-0.111	9.159
50	21.458	-1.552	-1.564	-2.282	-1.036
51	23.041	-6.357	-2.045	-3.093	9.162
52	23.791	-3.222	1.882	3.867	2.519
53	24.269	-4.672	1.737	3.622	5.596
54	21.055	-3.233	-3.670	-6.015	2.527
55	21.533	-4.684	-3.815	-6.260	5.605

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.228m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 1.000 m Governing Load Case : # 24

Width (W_2) = 1.000 m Governing Load Case : # 24

Depth (D_2) = 0.350 m Governing Load Case : # 47

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

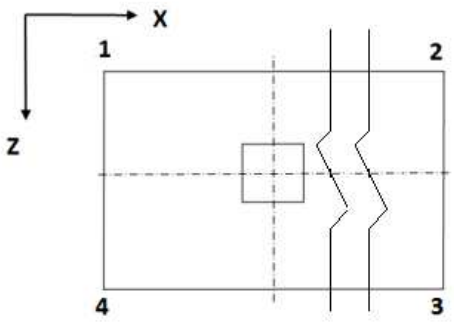
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.906 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
26	**124.8315**	1.3579	-34.1104	89.3632	0.131
38	75.9919	**47.4684**	-13.4221	15.1014	0.051
31	25.4402	31.9819	**38.8539**	32.3122	0.000
24	114.0655	-9.3848	-22.4817	**100.9686**	0.126

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

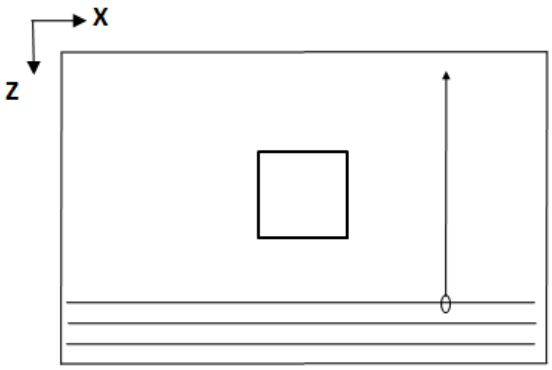
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**133.1748**	0.0000	0.0000	89.7868
38	77.0934	**47.1764**	0.0000	14.4317
31	25.4402	31.9819	**38.8539**	32.3122
24	118.8243	0.0000	0.0000	**103.1928**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 41

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.269	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	8.319	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	9.243	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00030	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00023	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected bar Size = #12

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars =	$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ =	=0.305	m
Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 12	Area of one bar =	113.097	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.269	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

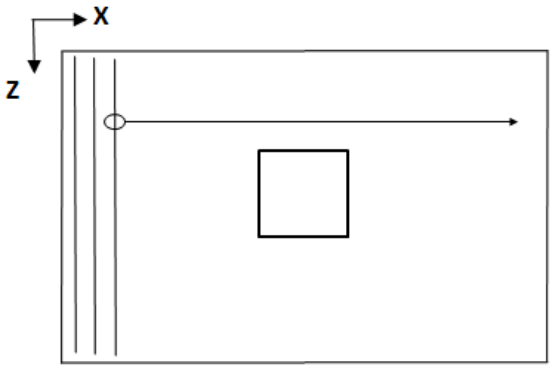
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 47

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.257	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	6.102	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	6.780	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00024	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00018	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	630.002	mm2

Selected Bar Size = #12

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 167.600mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Safe for Cracking Aspect.

Based on spacing reinforcement increment; provided reinforcement is

#12 @ 165.000mm o.c.

Required development length for bars = $\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ = 0.305 m

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.300	m	
Try bar size # 12	Area of one bar =	113.097	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	6		

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

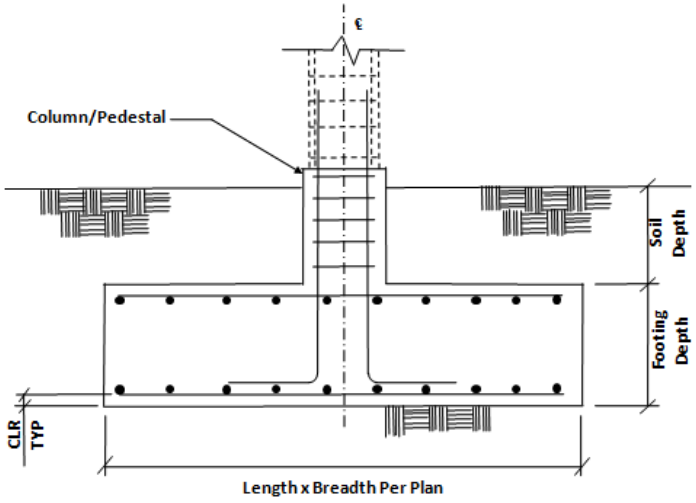
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

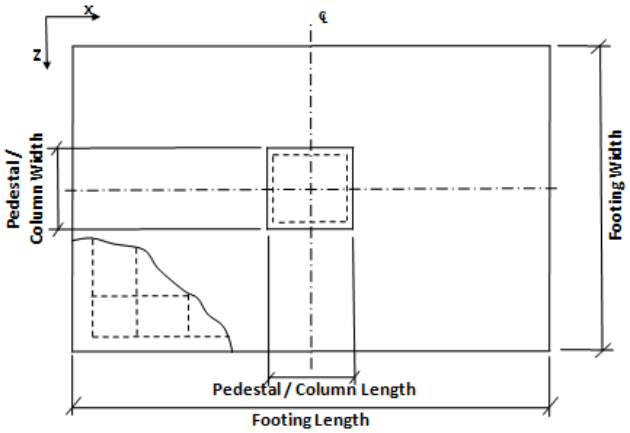
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 72



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	500.000mm
Footing Width - Z (Fw) :	500.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	#10
Maximum Bar Size :	#32
Pedestal Minimum Bar Size :	6
Pedestal Maximum Bar Size :	10
Minimum Bar Spacing :	50.000mm
Maximum Bar Spacing :	450.000mm
Pedestal Clear Cover (P, CL) :	75.000mm
Footing Clear Cover (F, CL) :	75.000mm

Soil Properties

Soil Type :	Drained
Unit Weight :	19.000kN/m3
Soil Bearing Capacity :	143.200kN/m2
Soil Bearing Capacity Type:	Gross Bearing Capacity
Soil Surcharge :	0.000kN/m2
Depth of Soil above Footing :	500.000mm
Cohesion :	0.000kN/m2

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Design Calculations

Footing Size

Initial Length (L_o) =	0.500m
Initial Width (W_o) =	0.500m

Load Combination/s- Service Stress Level				
Load		Load	Soil	Self

Combination Number	Load Combination Title	Combination Factor	Bearing Factor	Weight Factor
22	CM + CV	1.00	1.00	1.00
23	CM + 0,75 CV + 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
24	CM + 0,75 CV - 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
25	CM + 0,75 CV + 0.75 (0.7)(SX - 0,3 SZ)/R	1.00	1.00	1.00
26	CM + 0,75 CV - 0.75 (0.7)(SX + 0,3 SZ)/R	1.00	1.00	1.00
27	CM + 0,75 CV + 0.75 (0.7)(0,3 SX + SZ)/R	1.00	1.00	1.00
28	CM + 0,75 CV - 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
29	CM + 0,75 CV + 0.75 (0.7)(0.3 SX - SZ)/R	1.00	1.00	1.00
30	CM + 0,75 CV - 0.75 (0.7)(0.3 SX + SZ)/R	1.00	1.00	1.00
31	0.6 CM + 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
32	0.6 CM - 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
33	0.6 CM + 0.700 (SX - 0.3 SZ)/R	1.00	1.00	1.00
34	0.6 CM - 0.700 (SX + 0.3 SZ)/R	1.00	1.00	1.00
35	0.6 CM + 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
36	0.6 CM - 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00
37	0.6 CM - 0.700 (0.3 SX + SZ)/R	1.00	1.00	1.00
38	0.6 CM + 0.700 (0.3 SX - SZ)/R	1.00	1.00	1.00

Load Combination Number	Load Combination Title	Load Combination Factor	Soil Bearing Factor	Self Weight Factor
39	1.2 CM + 1.6 CV	1.00	1.00	1.00
40	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
41	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
42	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
43	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
44	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
45	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
46	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
47	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
48	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
49	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
50	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
51	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
52	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
53	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
54	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
55	0.9 CM - (0.3 SX/R + SZ/R)	1.00	1.00	1.00

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
22	21.933	0.278	2.416	2.242	-0.376
23	21.899	1.731	2.632	2.888	-3.100
24	20.787	-1.279	2.784	3.050	2.516
25	21.581	1.810	1.891	1.290	-3.231
26	20.469	-1.200	2.043	1.452	2.385
27	21.882	0.583	3.553	4.816	-0.978
28	21.550	-0.317	3.598	4.864	0.702
29	20.819	0.848	1.076	-0.524	-1.417
30	20.486	-0.053	1.122	-0.476	0.263
31	12.317	2.090	1.657	2.136	-3.837
32	10.834	-1.923	1.860	2.352	3.651

33	11.890	2.197	0.662	-0.009	-4.013
34	10.407	-1.817	0.865	0.207	3.475
35	12.294	0.565	2.882	4.699	-1.017
36	11.848	-0.644	2.943	4.764	1.240
37	10.429	-0.291	-0.360	-2.356	0.655
38	10.876	0.918	-0.421	-2.421	-1.602

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	27.519	0.353	3.024	2.807	-0.481
40	27.081	3.103	3.401	4.009	-5.639
41	24.970	-2.608	3.690	4.315	5.018
42	26.471	3.255	1.982	0.950	-5.890
43	24.361	-2.457	2.271	1.257	4.766
44	27.048	0.934	5.142	7.653	-1.628
45	26.411	-0.790	5.229	7.746	1.588
46	25.030	1.436	0.443	-2.480	-2.461
47	24.393	-0.288	0.530	-2.387	0.756
48	18.402	2.985	2.456	3.133	-5.474
49	16.292	-2.726	2.745	3.440	5.182
50	17.793	3.137	1.038	0.075	-5.725
51	15.683	-2.574	1.327	0.382	4.931
52	18.370	0.816	4.198	6.777	-1.463
53	17.733	-0.907	4.285	6.870	1.753
54	16.352	1.318	-0.502	-3.355	-2.296
55	15.715	-0.405	-0.415	-3.263	0.920

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 0.250 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.180 m^2$

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) = 0.900 m Governing Load Case : # 23

Width (W_2) = 0.900 m Governing Load Case : # 23

Depth (D_2) = 0.350 m Governing Load Case : # 42

Depth is governed by Ultimate Load Case

(Service check is performed with footing thickness requirements from concrete check)

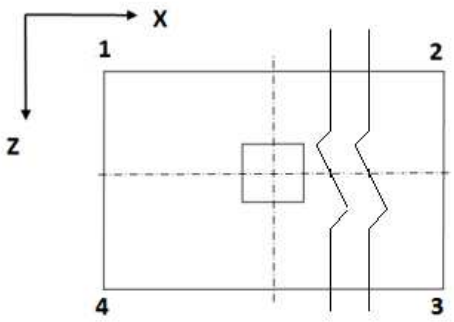
Area (A_2) = 0.810 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 6.804 kN

Soil Weight On Top Of Footing = 7.101 kN

Pressures at Four Corners



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
34	**59.6552**	-8.0140	0.3727	68.0419	0.047
33	-9.3488	**69.3712**	73.0386	-5.6814	0.078
23	-17.6464	43.3534	**106.0517**	45.0520	0.036
28	0.0606	-13.3223	87.4812	**100.8641**	0.053

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of Adjusted Pressures at 4 corners Four Corners

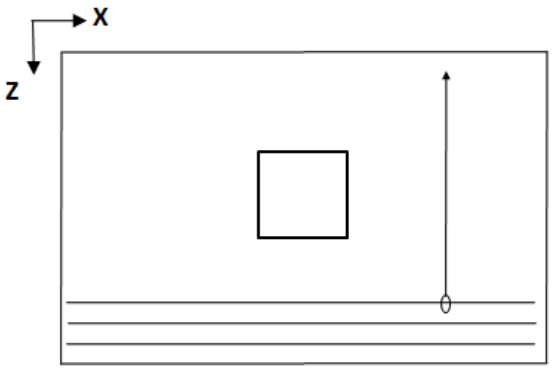
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**59.9182**	0.0000	0.0000	68.8462
33	0.0000	**69.6523**	73.7952	0.0000
23	0.0000	42.9524	**107.2218**	44.6375
28	0.0000	0.0000	87.9947	**102.4098**

Compression Development Length Check

Development length skipped as column reinforcement is not specified in input (Column Dimnesion Task Pane)

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



PLAN

Calculate the flexural reinforcement along the X direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 40

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.267	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl. 7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about Z axis is performed at the face of the column at a distance, D_x =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	5.136	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	5.707	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00021	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00016	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected bar Size = #16

Minimum spacing allowed (S_{min}) = = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = $\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}}$ = =0.305 m

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot - C_{cover}$ = 0.250 m

Try bar size # 16 Area of one bar = 201.064 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 3

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} = N_{bar} X (Area of one bar) = 603.192 mm2

d_{eff} = D - C_{cover} - 0.5 X (dia. of one bar) = 0.267 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00251

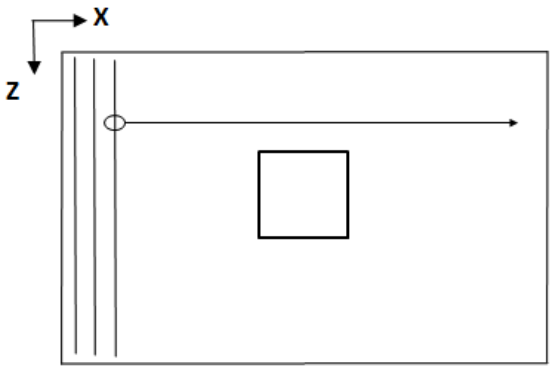
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



PLAN

Calculate the flexural reinforcement along the Z direction of the footing. Find the area of steel required, A, as per Section 3.8 of Reinforced Concrete Design (5th ed.) by Salmon and Wang (Ref. 1)

Critical Load Case # 45

The strength values of steel and concrete used in the formulae are in ksi

Bars parallel to X Direction are placed at bottom

Effective Depth d_{eff}=		0.251	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c' \times \frac{87}{[f_y \times (87 + F_y)]}$ =	0.02125	
From ACI Cl. 10.3.3, ρ_{max} =	$0.75 \times \rho_{bal}$ =	0.01594	
From ACI Cl.7.12.2, ρ_{min} =		0.00180	
From Ref. 1, Eq. 3.8.4a, constant m =	$\frac{F_y}{(0.85 \times F_c')}$ =	23.529	

Calculate reinforcement ratio ρ for critical load case

Design for flexure about X axis is performed at the face of the column at a distance, D_z =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	6.420	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	7.133	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00028	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00021	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	567.001	mm2

Selected Bar Size = #16

Minimum spacing allowed (S_{min}) = 50.000mm

Selected spacing (S) = 367.000mm

S_{min}<= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

According to ACI 318 Clause No- 10.6.4

Max spacing for Cracking Consideration = 187.772mm

Warning:Calculated spacing is more than maximum spacing cosidering cracking condition. Modify spacing manually if cracking consideration is necessary.

Based on spacing reinforcement increment; provided reinforcement is

#16 @ 365.000mm o.c.

Required development length for bars = 0.305 m

$$\frac{0.87 \times d_b \times f_y}{4 \times \beta \times \sqrt{f_c}} =$$

Available development length for bars, D_L =	$0.5 \times (L - D_{col}) \cdot - C_{cover} =$	0.250	m
Try bar size # 16	Area of one bar =	201.064	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}} =$	3	

Because the number of bars is rounded up, make sure new reinforcement ratio < ρ_{max}

Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	603.192	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.251	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)} =$	0.00267	

From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Print Calculation Sheet