Isolated Footing Design(ACI 318-11)

Design For Isolated Footing 20

Design For Isolated Footing 21

Design For Isolated Footing 22

Design For Isolated Footing 24

Design For Isolated Footing 28

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Design For Isolated Footing 30

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Design For Isolated Footing 65

Design For Isolated Footing 134

Design For Isolated Footing 144

Design For Isolated Footing 145

Design For Isolated Footing 146

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
20	1	1.100m	1.100m	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
20	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
21	2	1.100m	1.100m	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
21	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
22	3	1.100m	1.100m	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
22	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
24	4	1.100m	1.100m	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
24	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
28	5	1.100m	1.100m	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
28	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
29	6	1.100m	1.100m	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
29	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
30	7	1.100m	1.100m	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
30	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
31	8	1.100m	1.100m	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
31	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness

32	9	1.100m	1.100m	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
32	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
35	10	1.100m	1.100m	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
35	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
36	11	1.100m	1.100m	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
36	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
37	12	1.100m	1.100m	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
37	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
38	13	1.100m	1.100m	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
38	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
41	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
41	#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
43	15	1.100m	1.100m	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
43	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
45	16	1.100m	1.100m	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
45	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
49	17	1.200m	1.200m	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
49	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
51	18	1.200m	1.200m	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
51	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
53	19	1.200m	1.200m	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
53	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
55	20	1.200m	1.200m	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
55	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
57	21	1.200m	1.200m	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
57	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
59	22	1.200m	1.200m	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	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
61	23	1.200m	1.200m	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	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
63	24	1.200m	1.200m	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	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
65	25	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
65	#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
134	26	1.100m	1.100m	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
134	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
144	27	1.100m	1.100m	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
144	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

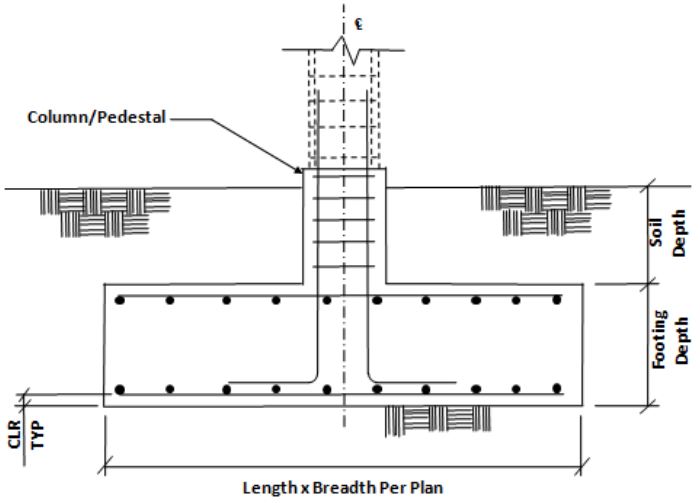
Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
145	28	1.100m	1.100m	0.350m

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
145	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

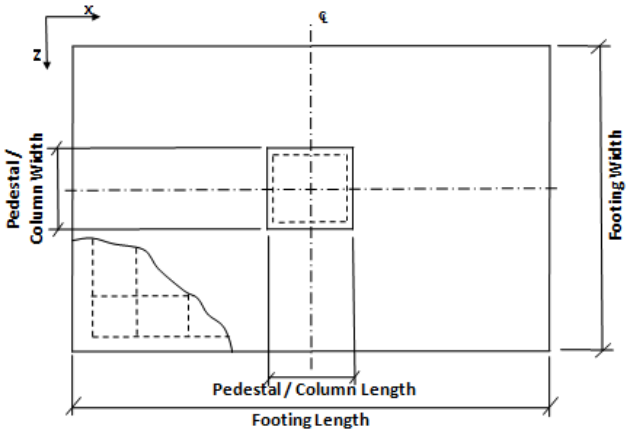
Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
146	29	1.100m	1.100m	0.350m

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
146	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	#10 @ 115 mm c/c	N/A	N/A

Isolated Footing 20



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	48.797	-1.248	-4.081	4.230	-0.156
23	44.082	2.351	-3.342	5.457	-6.641
24	49.098	-4.073	-3.554	5.132	4.960
25	46.084	1.663	-4.559	3.437	-5.441
26	51.099	-4.761	-4.771	3.112	6.160
27	43.490	0.906	-1.986	7.716	-3.982
28	44.987	-1.011	-2.049	7.619	-0.520
29	50.195	-1.399	-6.064	0.950	0.038
30	51.692	-3.317	-6.127	0.853	3.501
31	21.726	4.076	-1.444	4.224	-8.797
32	28.389	-4.458	-1.724	3.791	6.613

33	24.379	3.164	-3.056	1.547	-7.207
34	31.041	-5.370	-3.337	1.115	8.203
35	20.938	2.155	0.360	7.228	-5.262
36	22.922	-0.386	0.276	7.099	-0.674
37	31.829	-3.449	-5.140	-1.889	4.667
38	29.845	-0.908	-5.057	-1.761	0.079

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	60.486	-1.565	-4.935	4.988	-0.051
40	50.905	5.307	-3.512	7.361	-12.440
41	60.450	-6.918	-3.915	6.741	9.635
42	54.733	3.991	-5.840	3.498	-10.145
43	64.278	-8.234	-6.243	2.878	11.931
44	49.780	2.564	-0.937	11.651	-7.392
45	52.643	-1.103	-1.058	11.465	-0.769
46	62.540	-1.823	-8.697	-1.226	0.259
47	65.403	-5.491	-8.817	-1.412	6.882
48	32.889	5.800	-2.220	6.245	-12.631
49	42.434	-6.425	-2.623	5.625	9.444
50	36.717	4.484	-4.548	2.382	-10.336
51	46.262	-7.741	-4.951	1.762	11.740
52	31.764	3.057	0.355	10.535	-7.583
53	34.627	-0.611	0.234	10.349	-0.960
54	44.524	-1.330	-7.405	-2.342	0.068
55	47.387	-4.998	-7.526	-2.527	6.691

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.478 m^2$

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) = 1.100 m Governing Load Case : # 31

Width (W_2) = 1.100 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)

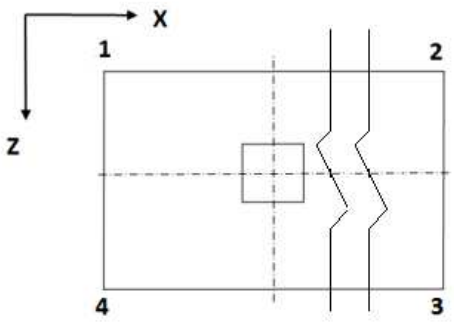
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**88.2814**	-2.6186	-3.0987	87.8013	0.048
25	19.5708	**73.8725**	90.4759	36.1743	0.000
23	0.3946	67.6886	**106.3438**	39.0498	0.000
24	68.7726	11.2041	46.2560	**103.8245**	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

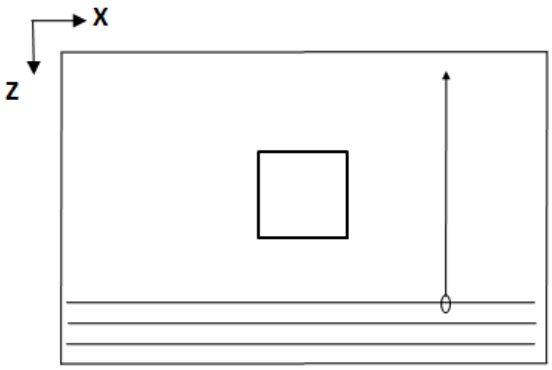
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**88.4282**	0.0000	0.0000	87.9253
25	19.5708	**73.8725**	90.4759	36.1743
23	0.3946	67.6886	**106.3438**	39.0498
24	68.7726	11.2041	46.2560	**103.8245**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	9.408	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	10.454	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00031	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00024	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

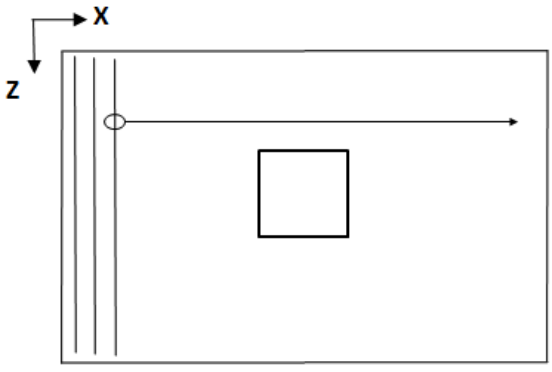
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	8.020	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.911	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 =		0.00021	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

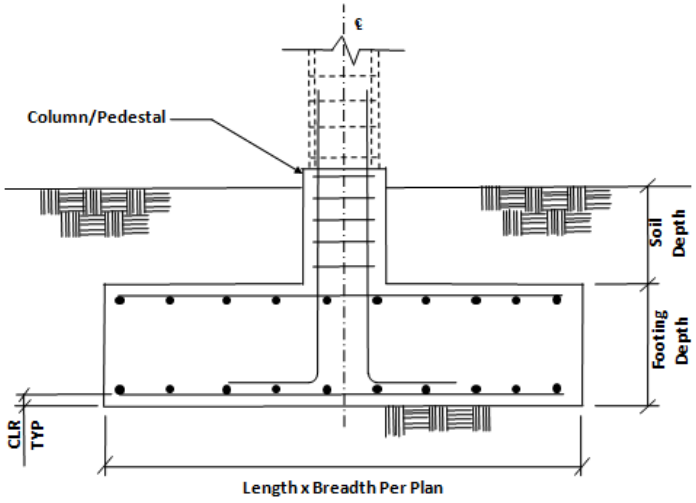
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

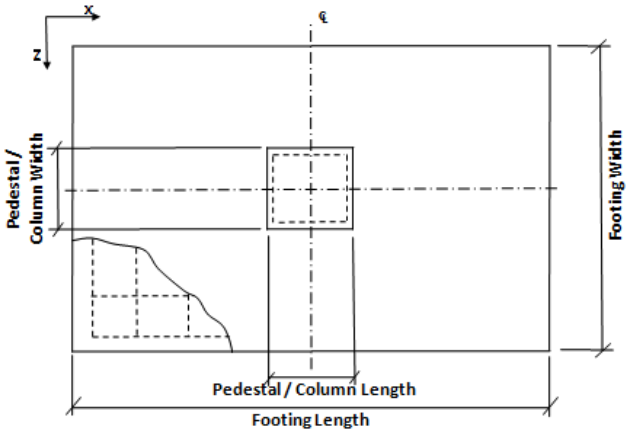
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 21



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	71.111	-1.896	-4.049	4.308	-1.170
23	65.988	2.397	-3.104	5.864	-7.703
24	69.261	-5.350	-3.133	5.852	4.170
25	68.280	1.592	-4.921	2.863	-6.497
26	71.553	-6.154	-4.950	2.852	5.376
27	64.443	0.625	-0.980	9.385	-4.956
28	65.420	-1.687	-0.989	9.381	-1.412
29	72.121	-2.070	-7.065	-0.666	-0.915
30	73.098	-4.383	-7.074	-0.670	2.629
31	33.356	4.582	-1.154	4.700	-9.371
32	37.704	-5.708	-1.192	4.685	6.401

33	36.393	3.516	-3.561	0.725	-7.773
34	40.741	-6.774	-3.599	0.709	7.999
35	31.302	2.226	1.670	9.383	-5.718
36	32.596	-0.838	1.659	9.378	-1.022
37	42.795	-4.418	-6.424	-3.973	4.346
38	41.501	-1.354	-6.413	-3.969	-0.350

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	89.079	-2.303	-4.894	5.089	-1.415
40	78.154	5.879	-3.077	8.089	-13.850
41	84.384	-8.863	-3.132	8.067	8.744
42	82.538	4.340	-6.551	2.351	-11.542
43	88.767	-10.402	-6.605	2.329	11.052
44	75.221	2.515	0.957	14.776	-8.633
45	77.090	-1.908	0.941	14.769	-1.855
46	89.832	-2.615	-10.623	-4.351	-0.943
47	91.700	-7.037	-10.639	-4.358	5.836
48	50.267	6.496	-1.801	6.937	-13.480
49	56.496	-8.245	-1.856	6.915	9.114
50	54.650	4.958	-5.275	1.199	-11.172
51	60.879	-9.784	-5.329	1.177	11.422
52	47.333	3.132	2.233	13.624	-8.264
53	49.202	-1.290	2.217	13.617	-1.485
54	61.944	-1.997	-9.347	-5.503	-0.573
55	63.813	-6.420	-9.363	-5.510	6.206

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.627 m^2$

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) = 1.100 m Governing Load Case : # 23

Width (W_2) = 1.100 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)

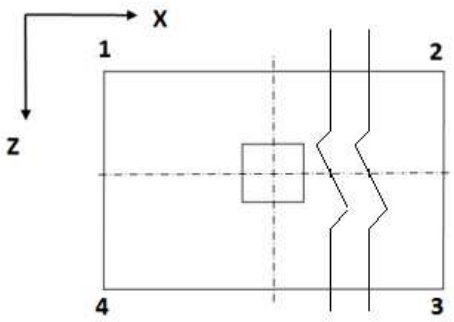
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**110.2957**	72.7607	44.4022	81.9372	0.000
25	36.4237	**100.0235**	110.3102	46.7105	0.000
27	6.1063	52.7656	**134.2858**	87.6265	0.000
24	79.9783	25.5029	68.3778	**122.8532**	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

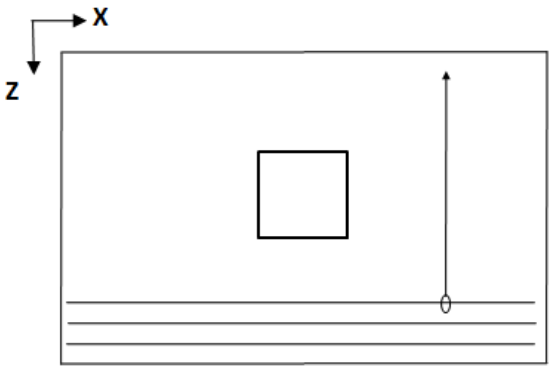
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**110.2957**	72.7607	44.4022	81.9372
25	36.4237	**100.0235**	110.3102	46.7105
27	6.1063	52.7656	**134.2858**	87.6265
24	79.9783	25.5029	68.3778	**122.8532**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	10.941	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.157	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

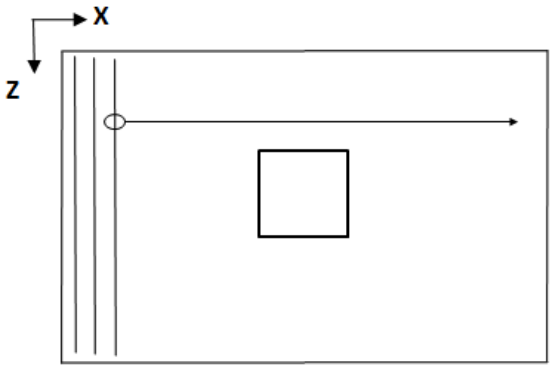
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.563	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.737	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00038	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

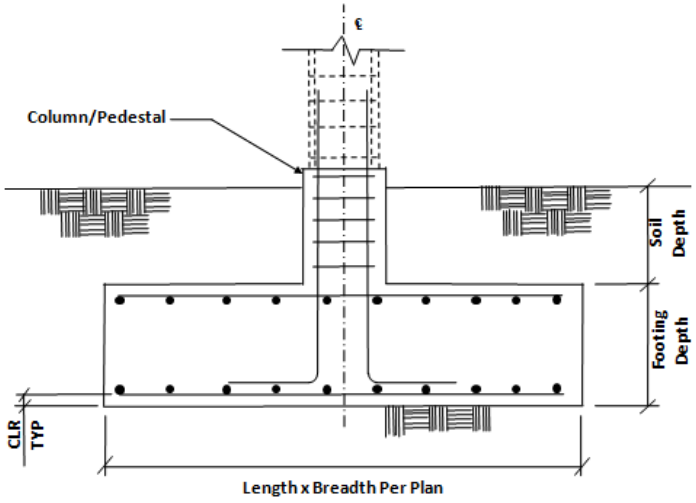
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

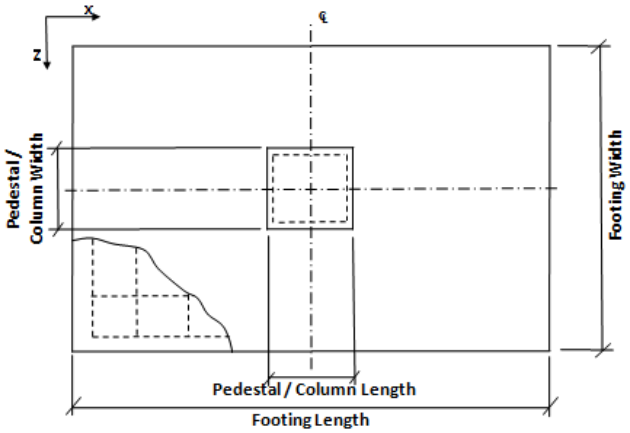
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 22



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	71.321	1.787	-4.079	4.271	1.268
23	69.624	6.074	-3.064	5.963	-5.307
24	66.379	-1.697	-3.047	5.959	6.593
25	71.545	5.267	-5.063	2.690	-4.091
26	68.300	-2.503	-5.045	2.686	7.809
27	66.230	4.296	-0.710	9.807	-2.563
28	65.261	1.976	-0.705	9.806	0.990
29	72.664	1.594	-7.404	-1.157	1.513
30	71.695	-0.725	-7.399	-1.158	5.065
31	38.015	6.763	-1.077	4.861	-7.989
32	33.704	-3.559	-1.054	4.856	7.819

33	40.560	5.694	-3.724	0.524	-6.377
34	36.249	-4.628	-3.701	0.520	9.431
35	33.500	4.398	2.054	9.973	-4.339
36	32.217	1.325	2.061	9.972	0.367
37	40.764	-2.263	-6.832	-4.593	5.781
38	42.047	0.810	-6.838	-4.591	1.074

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	89.359	2.148	-4.934	5.041	1.548
40	84.949	10.308	-2.981	8.301	-10.978
41	78.774	-4.480	-2.948	8.294	11.667
42	88.622	8.765	-6.803	2.042	-8.651
43	82.447	-6.022	-6.770	2.035	13.994
44	78.502	6.931	1.489	15.602	-5.767
45	76.650	2.495	1.499	15.600	1.027
46	90.746	1.791	-11.250	-5.263	1.989
47	88.894	-2.645	-11.240	-5.265	8.783
48	56.949	9.766	-1.689	7.169	-11.405
49	50.774	-5.021	-1.656	7.162	11.241
50	60.622	8.224	-5.511	0.909	-9.078
51	54.447	-6.563	-5.478	0.902	13.567
52	50.502	6.390	2.781	14.469	-6.193
53	48.650	1.954	2.791	14.467	0.600
54	62.746	1.249	-9.958	-6.396	1.562
55	60.894	-3.187	-9.948	-6.398	8.356

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.624 m^2$

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) = 1.100 m Governing Load Case : # 23

Width (W_2) = 1.100 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)

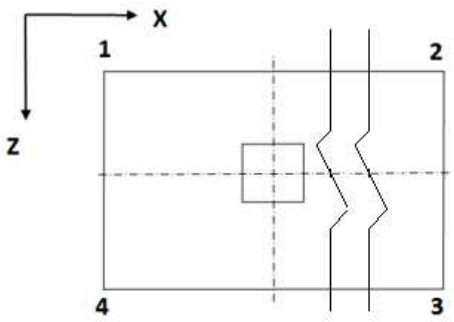
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**117.0623**	69.1081	35.3170	83.2712	0.000
25	45.1772	**98.6780**	106.9543	53.4536	0.000
27	10.2530	46.9125	**133.0925**	96.4330	0.000
24	82.1381	17.3427	61.4552	**126.2506**	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

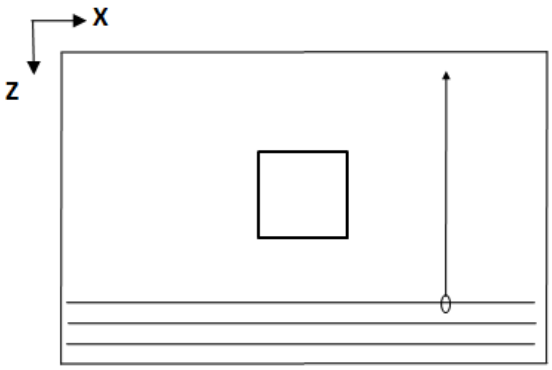
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**117.0623**	69.1081	35.3170	83.2712
25	45.1772	**98.6780**	106.9543	53.4536
27	10.2530	46.9125	**133.0925**	96.4330
24	82.1381	17.3427	61.4552	**126.2506**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.917	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.130	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

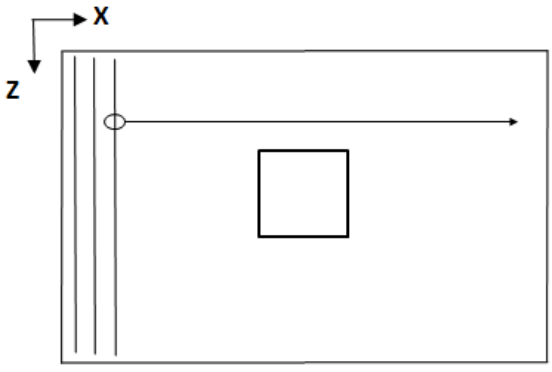
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.948	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.164	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00039	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	ρ≤ ρ_{min}	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

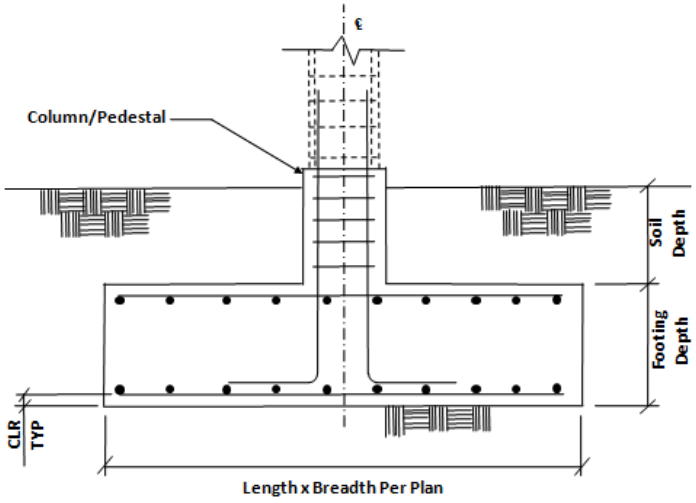
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

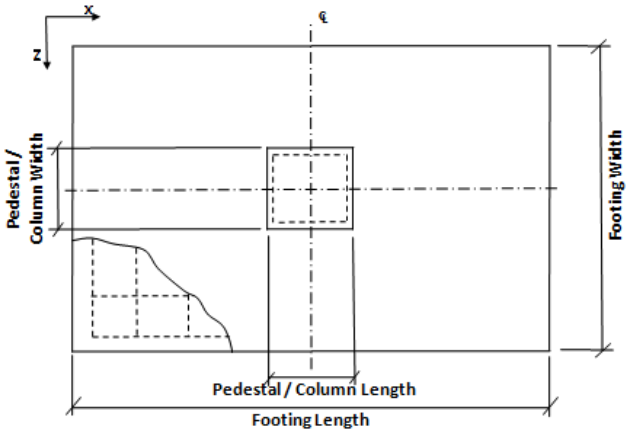
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 24



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	78.704	0.196	0.050	-0.894	-0.401
23	75.309	2.308	1.057	0.776	-5.692
24	78.108	-1.959	1.062	0.750	4.901
25	75.338	2.319	-0.961	-2.401	-5.638
26	78.137	-1.948	-0.956	-2.426	4.955
27	76.256	0.799	3.429	4.499	-2.040
28	77.092	-0.475	3.431	4.491	1.122
29	76.354	0.835	-3.330	-6.142	-1.859
30	77.190	-0.439	-3.329	-6.149	1.303
31	40.590	2.907	1.363	1.750	-7.233
32	44.308	-2.762	1.370	1.716	6.837

33	40.629	2.921	-1.311	-2.459	-7.162
34	44.347	-2.747	-1.303	-2.492	6.909
35	41.850	0.899	4.519	6.701	-2.378
36	42.957	-0.789	4.521	6.691	1.812
37	43.087	-0.740	-4.459	-7.444	2.053
38	41.980	0.948	-4.461	-7.434	-2.136

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	97.614	0.260	0.061	-1.183	-0.534
40	90.169	4.272	1.985	2.044	-10.586
41	95.495	-3.849	1.995	1.996	9.572
42	90.225	4.293	-1.874	-4.031	-10.482
43	95.551	-3.828	-1.864	-4.079	9.675
44	91.968	1.405	6.491	9.114	-3.652
45	93.565	-1.031	6.494	9.100	2.396
46	92.154	1.475	-6.373	-11.135	-3.306
47	93.752	-0.961	-6.370	-11.150	2.741
48	61.011	4.169	1.969	2.504	-10.374
49	66.338	-3.952	1.979	2.456	9.784
50	61.067	4.190	-1.890	-3.570	-10.270
51	66.394	-3.931	-1.880	-3.618	9.887
52	62.810	1.303	6.475	9.575	-3.440
53	64.408	-1.134	6.478	9.560	2.608
54	62.997	1.372	-6.389	-10.674	-3.094
55	64.595	-1.064	-6.386	-10.689	2.953

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.666m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

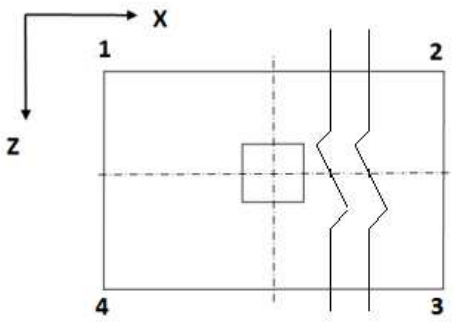
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**120.2706**	107.1371	41.1909	54.3244	0.000
29	103.2845	**122.6791**	56.7960	37.4014	0.000
27	43.8094	64.7245	**116.1090**	95.1939	0.000
28	60.7954	49.1825	100.5040	**112.1169**	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

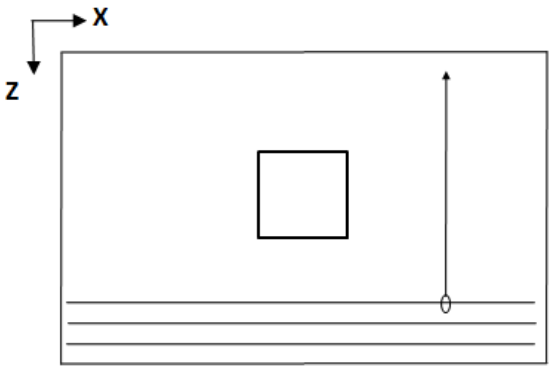
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**120.2706**	107.1371	41.1909	54.3244
29	103.2845	**122.6791**	56.7960	37.4014
27	43.8094	64.7245	**116.1090**	95.1939
28	60.7954	49.1825	100.5040	**112.1169**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.384	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.538	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

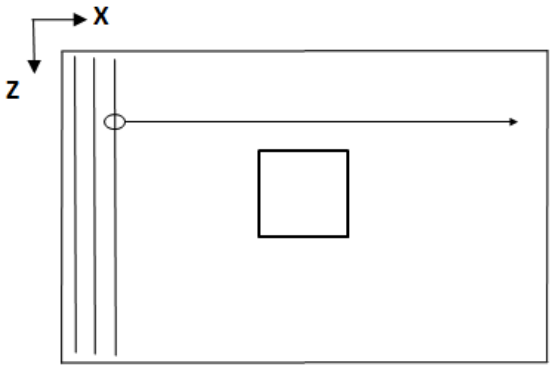
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.906	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.118	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00039	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

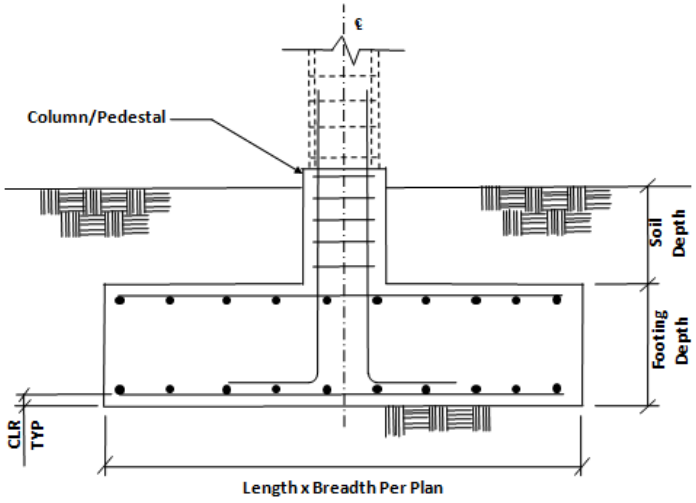
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

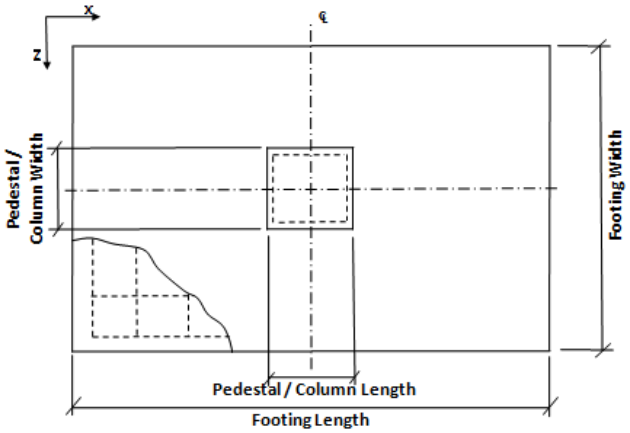
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 28



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	64.759	-2.420	3.490	-4.902	-1.200
23	65.451	0.459	4.539	-3.224	-5.581
24	63.100	-6.097	4.526	-3.262	4.341
25	63.754	1.250	2.500	-6.528	-6.772
26	61.403	-5.306	2.486	-6.565	3.150
27	66.620	-2.770	6.930	0.645	-0.702
28	65.918	-4.727	6.926	0.633	2.259
29	60.936	-0.120	0.099	-10.423	-4.691
30	60.234	-2.077	0.095	-10.434	-1.729
31	38.345	2.370	3.508	-0.711	-6.559
32	35.222	-6.339	3.490	-0.761	6.621

33	36.097	3.418	0.806	-5.088	-8.136
34	32.974	-5.291	0.788	-5.138	5.044
35	39.900	-1.924	6.688	4.434	-0.071
36	38.970	-4.517	6.683	4.419	3.854
37	31.419	-0.997	-2.392	-10.283	-1.444
38	32.349	1.596	-2.386	-10.268	-5.369

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	79.841	-2.898	4.152	-5.893	-1.415
40	80.504	2.575	6.169	-2.682	-9.755
41	76.031	-9.902	6.143	-2.753	9.127
42	77.259	4.088	2.269	-9.000	-12.032
43	72.786	-8.389	2.244	-9.071	6.850
44	82.725	-3.557	10.710	4.665	-0.490
45	81.383	-7.300	10.702	4.643	5.175
46	71.908	1.486	-2.290	-16.396	-8.079
47	70.566	-2.257	-2.297	-16.418	-2.415
48	57.348	3.291	5.185	-1.192	-9.438
49	52.875	-9.186	5.159	-1.263	9.443
50	54.103	4.804	1.285	-7.510	-11.715
51	49.630	-7.673	1.259	-7.582	7.166
52	59.569	-2.841	9.726	6.154	-0.174
53	58.227	-6.584	9.718	6.133	5.491
54	48.752	2.202	-3.274	-14.907	-7.763
55	47.410	-1.541	-3.282	-14.928	-2.099

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.582m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

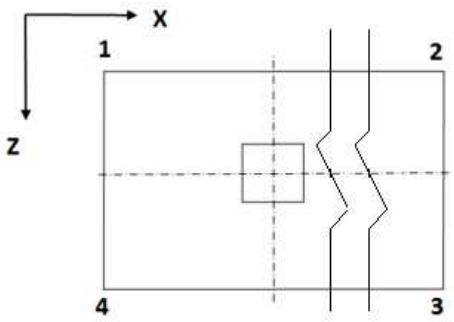
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**115.9299**	70.7853	19.4386	64.5832	0.000
29	93.1713	**135.0834**	41.4243	-0.4878	0.000
23	52.5175	104.2872	**89.5411**	37.7714	0.000
36	43.1804	-5.8179	55.1081	**104.1064**	0.006

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

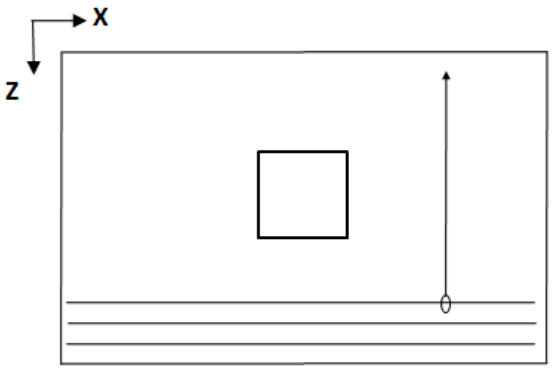
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**115.9299**	70.7853	19.4386	64.5832
29	93.1713	**135.0835**	41.4242	0.0000
23	52.5175	104.2872	**89.5411**	37.7714
36	43.1862	0.0000	55.1155	**104.1768**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	9.955	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.061	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 =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

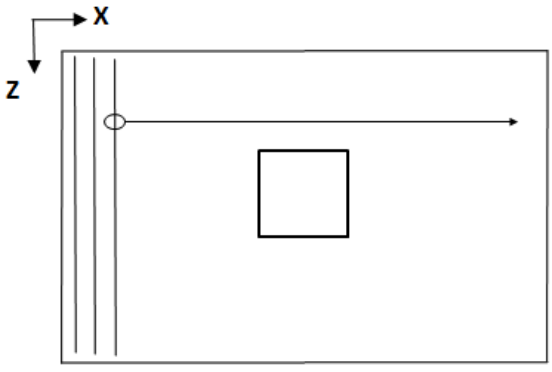
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.539	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.709	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00038	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

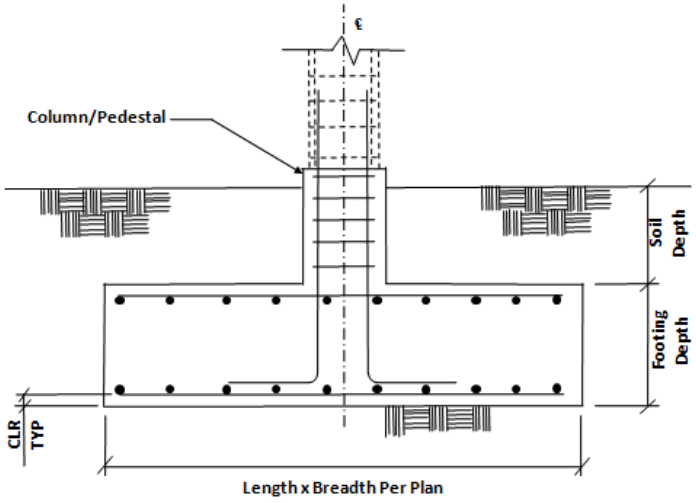
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

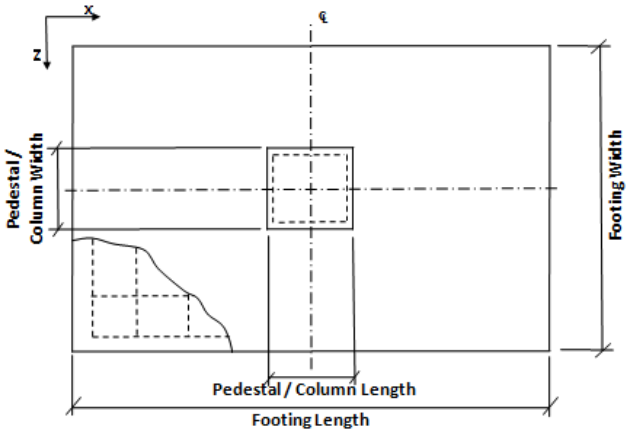
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 29



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	64.554	2.625	3.519	-4.835	1.216
23	63.059	5.527	4.464	-3.329	-3.131
24	65.478	-1.046	4.468	-3.313	6.772
25	61.000	6.316	2.610	-6.355	-4.324
26	63.419	-0.257	2.614	-6.339	5.578
27	66.326	2.295	6.644	0.231	1.745
28	67.048	0.333	6.645	0.236	4.701
29	59.430	4.937	0.433	-9.904	-2.253
30	60.152	2.975	0.434	-9.899	0.703
31	35.334	5.442	3.385	-0.904	-5.038
32	38.547	-3.288	3.391	-0.883	8.116

33	32.606	6.487	0.929	-4.913	-6.620
34	35.819	-2.243	0.934	-4.892	6.535
35	39.679	1.145	6.284	3.830	1.446
36	40.636	-1.455	6.285	3.837	5.362
37	31.474	2.054	-1.964	-9.627	0.051
38	30.518	4.654	-1.966	-9.633	-3.866

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	79.569	3.133	4.191	-5.805	1.447
40	76.080	8.657	6.008	-2.923	-6.816
41	80.683	-3.850	6.016	-2.893	12.029
42	72.142	10.166	2.462	-8.710	-9.098
43	76.746	-2.342	2.470	-8.679	9.746
44	82.284	2.520	10.147	3.838	2.443
45	83.665	-1.232	10.149	3.847	8.097
46	69.160	7.548	-1.672	-15.450	-5.166
47	70.541	3.795	-1.669	-15.441	0.488
48	53.032	7.899	5.008	-1.469	-7.159
49	57.635	-4.609	5.016	-1.439	11.686
50	49.094	9.407	1.463	-7.255	-9.441
51	53.698	-3.101	1.471	-7.225	9.403
52	59.236	1.762	9.148	5.292	2.100
53	60.617	-1.991	9.150	5.301	7.754
54	46.112	6.789	-2.671	-13.995	-5.509
55	47.493	3.037	-2.669	-13.986	0.145

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.585 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

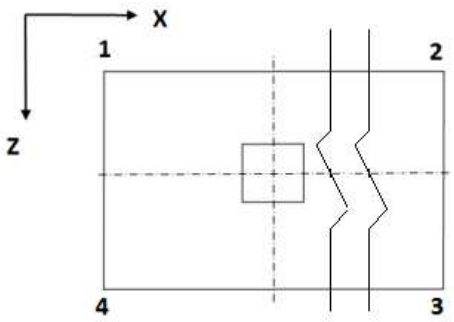
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**119.3534**	68.2480	19.3471	70.4525	0.000
29	92.0695	**127.9643**	40.0366	4.1418	0.000
23	54.1838	99.8511	**83.9208**	38.2536	0.000
28	81.4678	40.1347	63.2313	**104.5644**	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

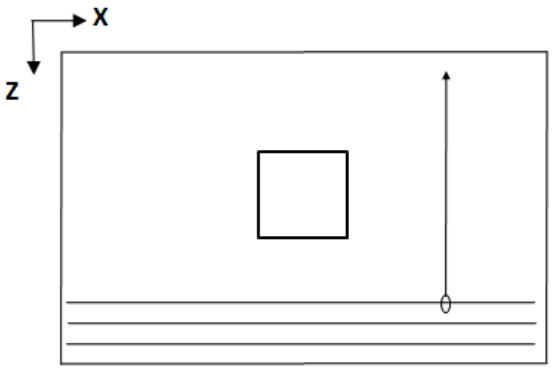
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**119.3534**	68.2480	19.3471	70.4525
29	92.0695	**127.9643**	40.0366	4.1418
23	54.1838	99.8511	**83.9208**	38.2536
28	81.4678	40.1347	63.2313	**104.5644**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.070	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.189	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 =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

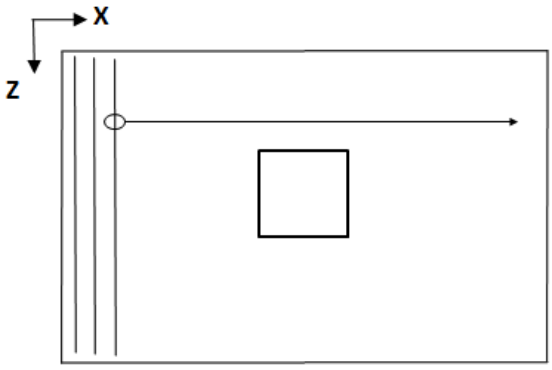
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.135	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.261	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

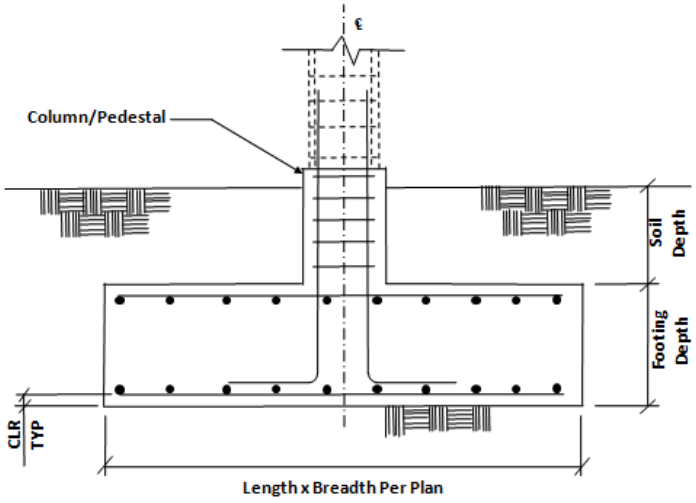
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

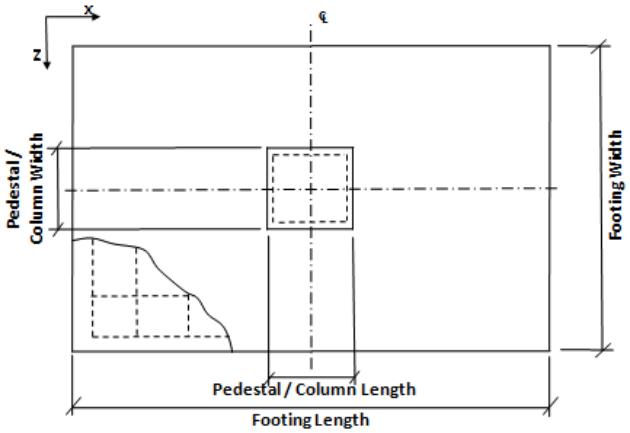
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 30



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	47.287	-2.732	3.463	-5.007	-3.401
23	45.674	-0.360	4.199	-3.816	-7.615
24	49.485	-5.713	4.025	-4.124	1.847
25	43.810	0.305	2.951	-5.856	-8.774
26	47.622	-5.049	2.776	-6.165	0.687
27	49.200	-3.018	5.605	-1.526	-2.934
28	50.338	-4.616	5.553	-1.618	-0.110
29	42.958	-0.792	1.423	-8.362	-6.818
30	44.096	-2.390	1.371	-8.454	-3.994
31	25.541	1.543	3.081	-1.408	-7.708
32	30.604	-5.569	2.849	-1.818	4.861

33	23.072	2.423	1.427	-4.112	-9.244
34	28.135	-4.688	1.195	-4.522	3.325
35	30.230	-1.992	4.950	1.636	-1.483
36	31.738	-4.110	4.881	1.514	2.259
37	23.445	-1.153	-0.674	-7.566	-2.900
38	21.938	0.964	-0.605	-7.444	-6.642

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	57.768	-3.322	4.115	-6.034	-3.980
40	54.389	1.203	5.535	-3.750	-12.025
41	61.642	-8.985	5.203	-4.337	5.980
42	50.825	2.473	3.148	-7.653	-14.243
43	58.078	-7.715	2.816	-8.240	3.763
44	61.085	-3.846	8.204	0.598	-3.137
45	63.261	-6.902	8.105	0.421	2.265
46	49.205	0.390	0.246	-12.411	-10.528
47	51.381	-2.666	0.147	-12.587	-5.126
48	38.412	2.099	4.567	-2.202	-11.181
49	45.665	-8.088	4.235	-2.789	6.824
50	34.848	3.370	2.180	-6.105	-13.399
51	42.101	-6.818	1.847	-6.692	4.607
52	45.109	-2.949	7.236	2.145	-2.293
53	47.285	-6.005	7.136	1.969	3.109
54	33.229	1.287	-0.722	-10.863	-9.683
55	35.405	-1.770	-0.822	-11.040	-4.282

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.468 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

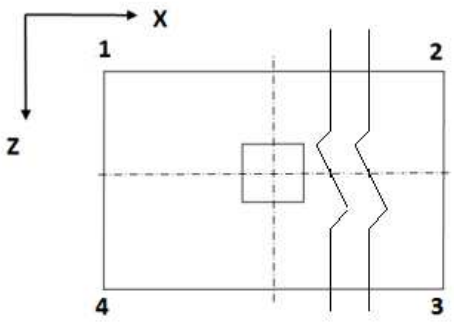
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**90.7685**	68.6407	21.8208	43.9486	0.000
29	58.4059	**117.3758**	46.4739	-12.4960	0.021
23	31.4992	99.0211	**77.8702**	10.3483	0.000
36	45.3071	11.9709	41.0274	**74.3635**	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

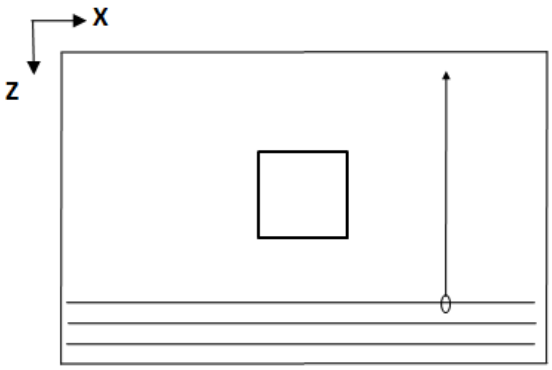
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**90.7685**	68.6407	21.8208	43.9486
29	58.1435	**117.6072**	46.1983	0.0000
23	31.4992	99.0211	**77.8702**	10.3483
36	45.3071	11.9709	41.0274	**74.3635**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	9.572	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	10.635	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00032	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00024	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

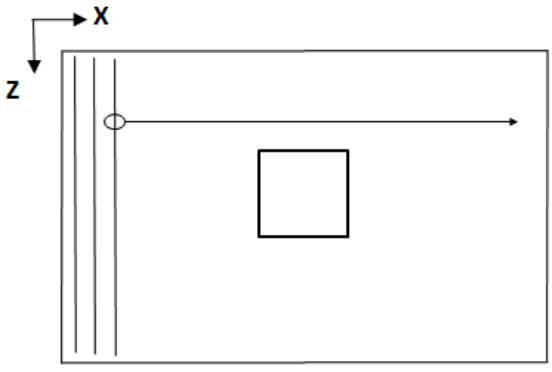
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	7.971	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.856	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 =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

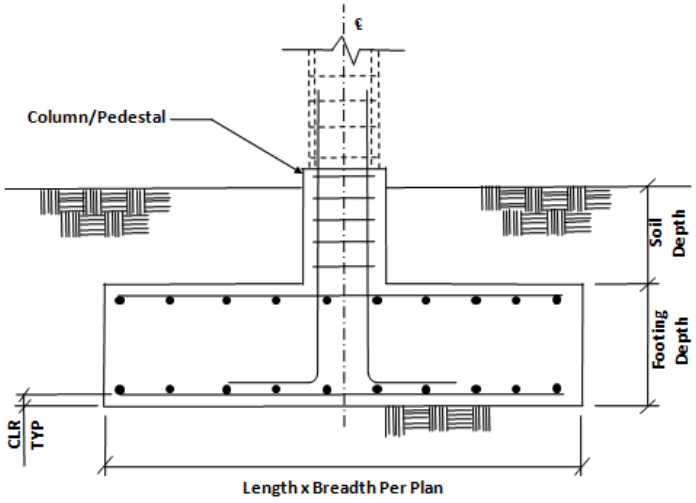
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

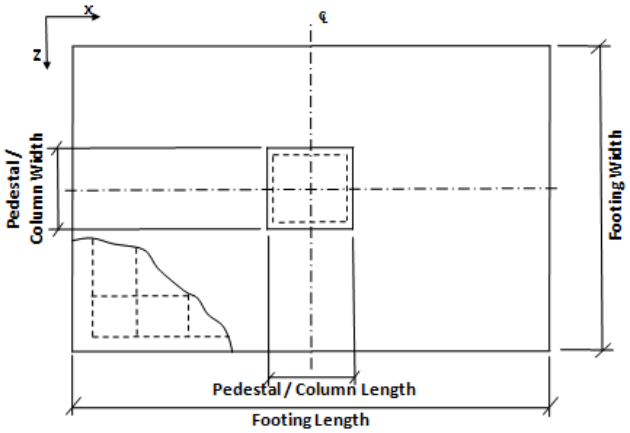
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 31



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	71.025	-0.056	-4.197	3.863	-0.006
23	67.175	4.075	-3.100	5.713	-6.547
24	67.081	-3.395	-3.099	5.715	5.312
25	69.575	3.284	-5.220	2.179	-5.328
26	69.481	-4.187	-5.219	2.180	6.532
27	64.322	2.385	-0.609	9.866	-3.820
28	64.294	0.155	-0.608	9.867	-0.280
29	72.362	-0.267	-7.711	-1.974	0.265
30	72.334	-2.497	-7.710	-1.973	3.805
31	34.614	5.454	-1.026	4.859	-8.692
32	34.490	-4.470	-1.024	4.861	7.062

33	37.794	4.405	-3.835	0.176	-7.076
34	37.670	-5.519	-3.833	0.178	8.677
35	30.821	3.206	2.288	10.382	-5.066
36	30.783	0.252	2.288	10.382	-0.375
37	41.464	-3.271	-7.146	-5.345	5.051
38	41.501	-0.317	-7.147	-5.346	0.361

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	89.545	-0.068	-5.095	4.502	-0.005
40	80.867	7.798	-2.981	8.080	-12.459
41	80.688	-6.418	-2.977	8.084	10.109
42	85.457	6.284	-7.035	1.321	-10.127
43	85.278	-7.932	-7.032	1.324	12.442
44	75.449	4.589	1.751	15.967	-7.281
45	75.395	0.324	1.752	15.968	-0.510
46	90.750	-0.458	-11.764	-6.564	0.493
47	90.696	-4.723	-11.763	-6.563	7.263
48	52.007	7.816	-1.618	7.155	-12.461
49	51.829	-6.400	-1.615	7.159	10.107
50	56.598	6.302	-5.673	0.396	-10.129
51	56.419	-7.914	-5.670	0.399	12.439
52	46.590	4.607	3.113	15.042	-7.283
53	46.536	0.342	3.114	15.043	-0.512
54	61.890	-0.440	-10.402	-7.489	0.491
55	61.837	-4.704	-10.401	-7.488	7.261

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.622 m^2$

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) = 1.100 m Governing Load Case : # 23

Width (W_2) = 1.100 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)

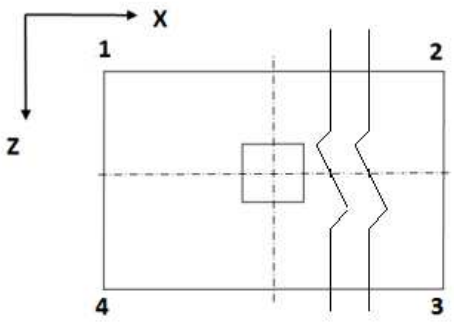
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**118.8692**	76.6874	34.5668	76.7486	0.000
25	43.6553	**102.0518**	105.2199	46.8234	0.000
27	5.5951	47.5650	**134.5973**	92.6274	0.000
24	80.8090	22.2006	63.9442	**122.5526**	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

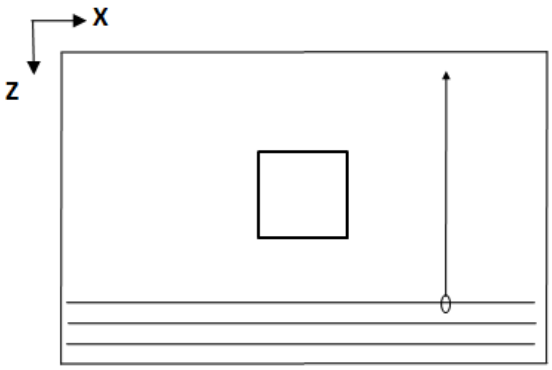
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**118.8692**	76.6874	34.5668	76.7486
25	43.6553	**102.0518**	105.2199	46.8234
27	5.5951	47.5650	**134.5973**	92.6274
24	80.8090	22.2006	63.9442	**122.5526**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.860	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.066	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

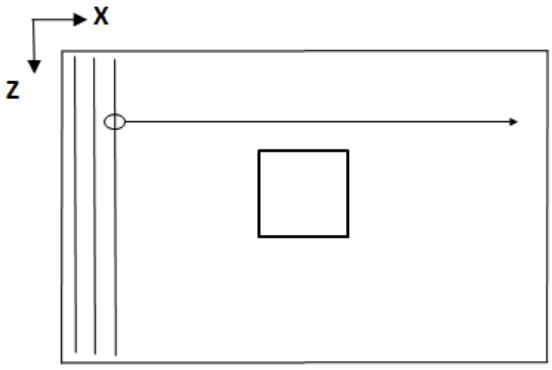
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	11.102	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.335	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00040	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

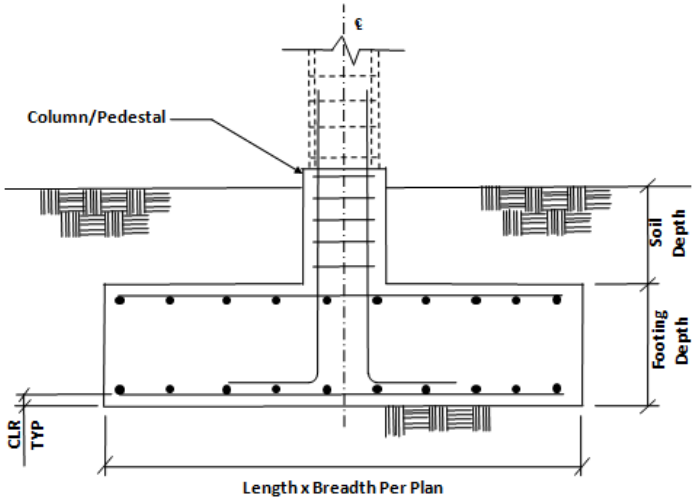
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

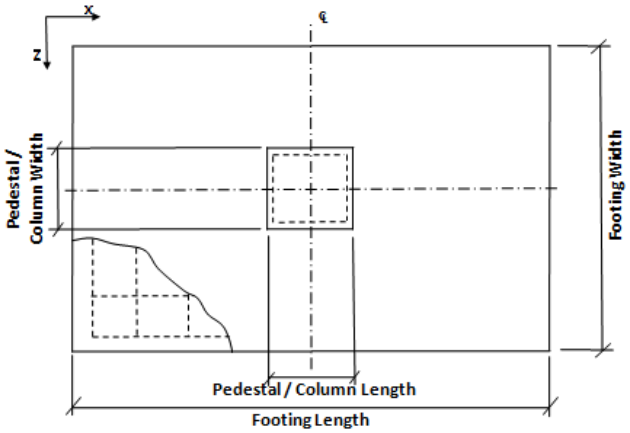
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 32



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	68.486	-0.170	3.307	-4.848	-0.065
23	68.122	2.609	4.436	-3.056	-4.419
24	68.044	-3.722	4.437	-3.054	5.477
25	66.006	3.382	2.247	-6.629	-5.610
26	65.927	-2.950	2.248	-6.627	4.286
27	70.581	-0.519	7.009	1.142	0.452
28	70.558	-2.409	7.009	1.143	3.406
29	63.492	2.069	-0.324	-10.825	-3.539
30	63.469	0.179	-0.324	-10.825	-0.585
31	39.038	3.592	3.518	-0.526	-5.826
32	38.934	-4.819	3.520	-0.524	7.320

33	36.234	4.616	0.618	-5.260	-7.404
34	36.130	-3.796	0.619	-5.257	5.742
35	42.308	-0.569	6.939	5.056	0.652
36	42.277	-3.073	6.939	5.057	4.566
37	32.860	0.365	-2.802	-10.840	-0.736
38	32.891	2.869	-2.802	-10.841	-4.650

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	84.522	-0.205	3.912	-5.830	-0.076
40	83.113	5.082	6.089	-2.398	-8.356
41	82.963	-6.968	6.091	-2.394	10.476
42	79.066	6.559	1.903	-9.230	-10.634
43	78.916	-5.490	1.904	-9.227	8.198
44	87.782	-0.859	10.974	5.574	0.893
45	87.737	-4.474	10.974	5.575	6.543
46	74.292	4.066	-2.981	-17.200	-6.701
47	74.247	0.451	-2.981	-17.199	-1.052
48	58.474	5.133	5.196	-0.924	-8.340
49	58.325	-6.916	5.197	-0.920	10.492
50	54.427	6.611	1.009	-7.756	-10.618
51	54.278	-5.439	1.011	-7.752	8.214
52	63.144	-0.808	10.080	7.049	0.909
53	63.099	-4.423	10.081	7.050	6.559
54	49.653	4.117	-3.874	-15.726	-6.685
55	49.609	0.502	-3.874	-15.725	-1.035

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.610 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

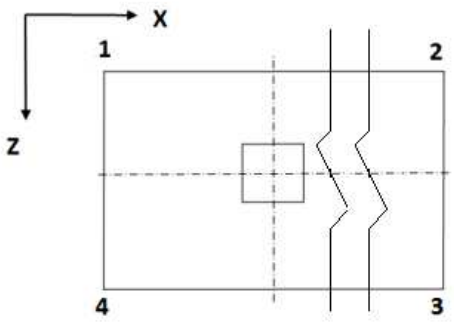
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**121.7242**	73.7728	21.1221	69.0735	0.000
29	99.5064	**137.9402**	39.3144	0.8806	0.000
23	55.9772	104.0508	**90.4965**	42.4230	0.000
36	43.5609	-7.2998	60.1934	**111.0540**	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

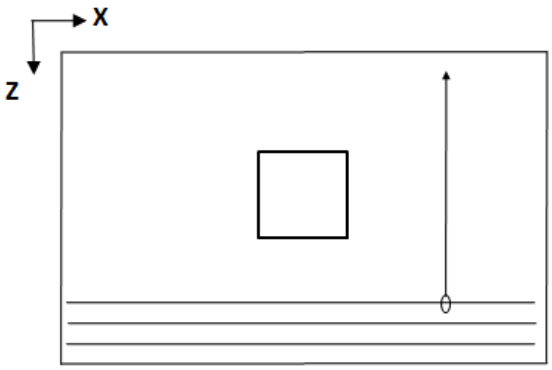
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**121.7242**	73.7728	21.1221	69.0735
29	99.5064	**137.9402**	39.3144	0.8806
23	55.9772	104.0508	**90.4965**	42.4230
36	43.5701	0.0000	60.2065	**111.1748**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	10.092	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.213	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 =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

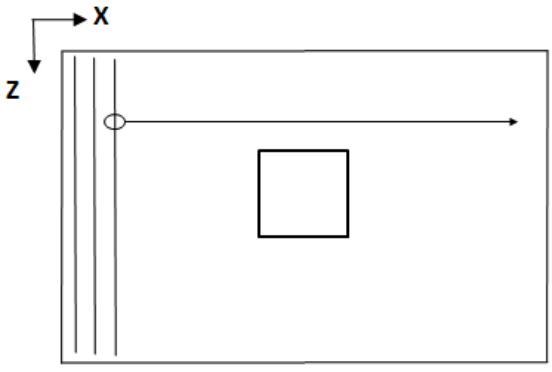
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.973	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.192	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00039	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	ρ≤ ρ_{min}	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

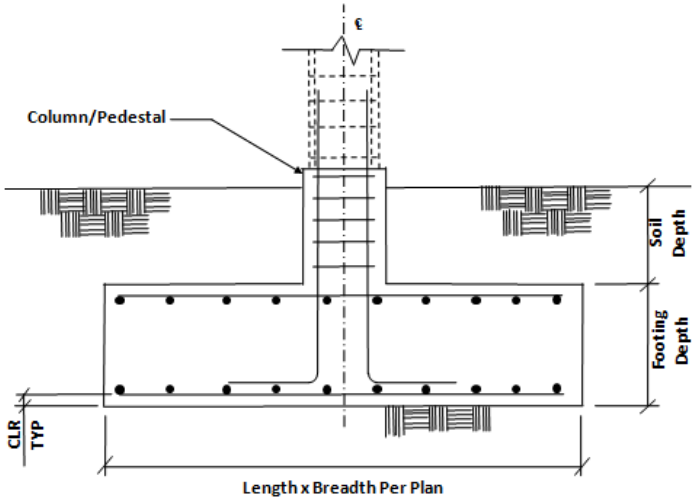
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

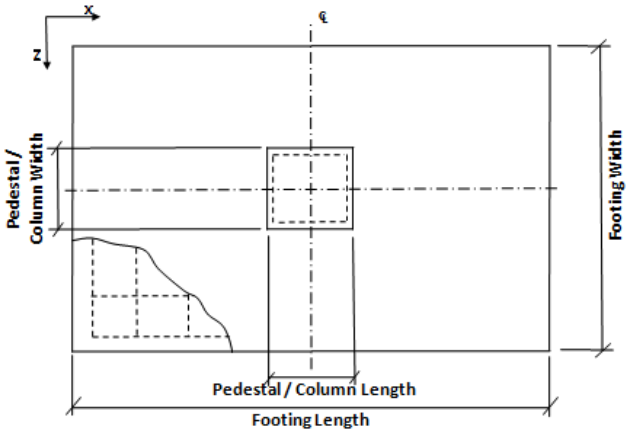
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 35



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	71.119	1.909	-4.051	4.302	1.166
23	69.455	6.169	-3.050	5.971	-5.385
24	66.189	-1.576	-3.021	5.984	6.488
25	71.367	5.360	-5.036	2.721	-4.169
26	68.100	-2.385	-5.007	2.734	7.704
27	66.064	4.403	-0.706	9.795	-2.649
28	65.089	2.091	-0.697	9.799	0.895
29	72.467	1.694	-7.360	-1.094	1.424
30	71.492	-0.618	-7.351	-1.090	4.968
31	37.955	6.785	-1.081	4.847	-8.007
32	33.616	-3.504	-1.042	4.865	7.764

33	40.488	5.713	-3.713	0.540	-6.396
34	36.149	-4.575	-3.674	0.558	9.375
35	33.445	4.436	2.036	9.932	-4.369
36	32.153	1.373	2.047	9.938	0.327
37	40.659	-2.226	-6.791	-4.528	5.737
38	41.951	0.837	-6.802	-4.533	1.041

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	89.089	2.318	-4.896	5.082	1.410
40	84.750	10.420	-2.972	8.299	-11.065
41	78.534	-4.318	-2.916	8.324	11.528
42	88.406	8.873	-6.770	2.082	-8.740
43	82.190	-5.865	-6.714	2.107	13.854
44	78.310	7.066	1.479	15.561	-5.870
45	76.445	2.645	1.496	15.568	0.908
46	90.495	1.910	-11.182	-5.162	1.881
47	88.630	-2.511	-11.165	-5.155	8.659
48	56.859	9.800	-1.695	7.150	-11.433
49	50.642	-4.939	-1.639	7.174	11.160
50	60.514	8.253	-5.493	0.933	-9.108
51	54.298	-6.486	-5.438	0.958	13.485
52	50.418	6.446	2.756	14.411	-6.239
53	48.553	2.024	2.773	14.419	0.539
54	62.603	1.290	-9.905	-6.311	1.513
55	60.738	-3.131	-9.889	-6.304	8.291

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.623 m^2$

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) = 1.100 m Governing Load Case : # 23

Width (W_2) = 1.100 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)

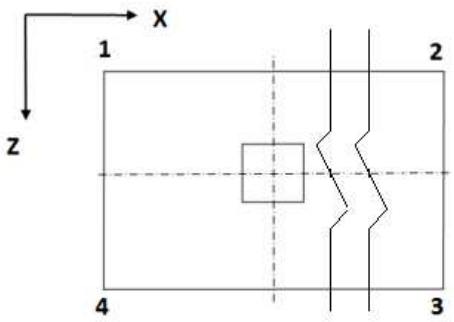
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**115.9073**	69.1615	36.1362	82.8820	0.000
25	44.3496	**98.8487**	107.4872	52.9881	0.000
27	9.6044	47.3805	**133.4673**	95.6912	0.000
24	81.1621	17.6933	62.1163	**125.5851**	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

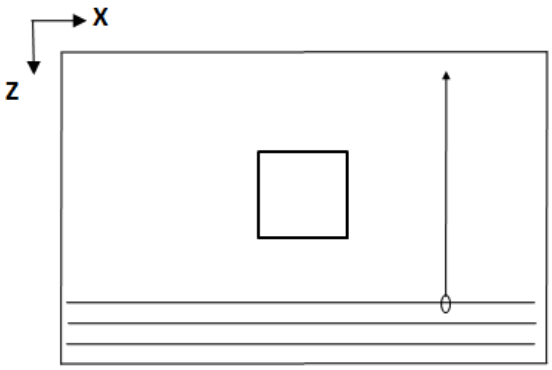
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**115.9073**	69.1615	36.1362	82.8820
25	44.3496	**98.8487**	107.4872	52.9881
27	9.6044	47.3805	**133.4673**	95.6912
24	81.1621	17.6933	62.1163	**125.5851**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.848	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.053	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

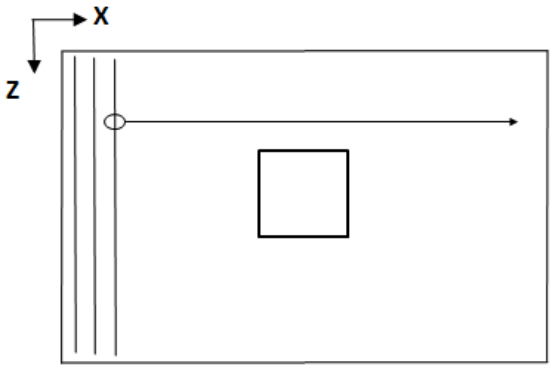
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.938	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.153	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00039	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

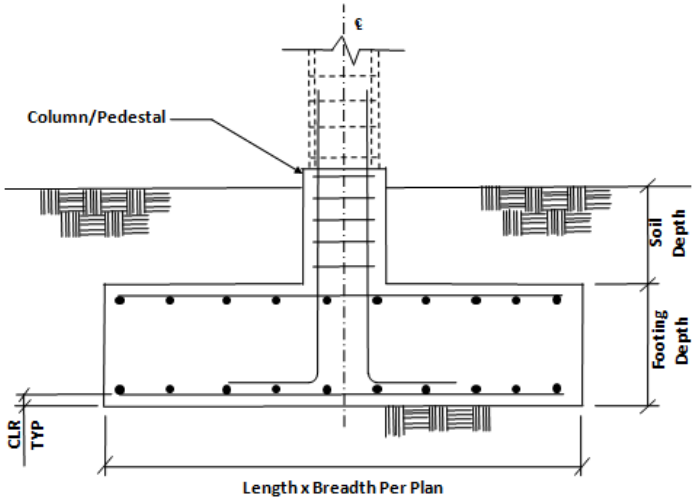
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

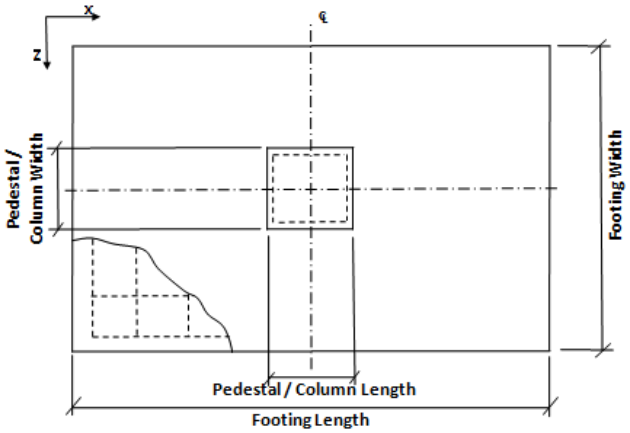
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 36



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	64.409	2.259	3.484	-4.910	1.133
23	62.995	5.147	4.441	-3.383	-3.215
24	65.270	-1.415	4.455	-3.343	6.706
25	60.919	5.939	2.558	-6.462	-4.412
26	63.194	-0.623	2.573	-6.422	5.510
27	66.231	1.915	6.657	0.249	1.670
28	66.910	-0.044	6.662	0.261	4.632
29	59.279	4.569	0.352	-10.066	-2.337
30	59.958	2.610	0.356	-10.054	0.624
31	35.354	5.198	3.383	-0.914	-5.083
32	38.376	-3.520	3.402	-0.861	8.096

33	32.604	6.247	0.889	-4.994	-6.668
34	35.626	-2.470	0.908	-4.941	6.511
35	39.657	0.899	6.331	3.916	1.414
36	40.557	-1.697	6.336	3.931	5.338
37	31.322	1.829	-2.040	-9.771	0.015
38	30.422	4.424	-2.046	-9.787	-3.910

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	79.395	2.705	4.143	-5.904	1.336
40	76.059	8.200	5.985	-2.979	-6.925
41	80.388	-4.288	6.012	-2.904	11.955
42	72.090	9.715	2.385	-8.868	-9.213
43	76.419	-2.773	2.412	-8.793	9.667
44	82.205	2.061	10.194	3.918	2.352
45	83.504	-1.685	10.203	3.940	8.016
46	68.975	7.112	-1.805	-15.713	-5.275
47	70.274	3.365	-1.797	-15.690	0.390
48	53.055	7.532	5.004	-1.485	-7.225
49	57.384	-4.956	5.032	-1.409	11.656
50	49.086	9.047	1.405	-7.374	-9.513
51	53.415	-3.441	1.432	-7.298	9.368
52	59.200	1.394	9.214	5.412	2.053
53	60.499	-2.353	9.222	5.435	7.717
54	45.970	6.444	-2.786	-14.218	-5.574
55	47.269	2.698	-2.778	-14.196	0.090

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.584m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

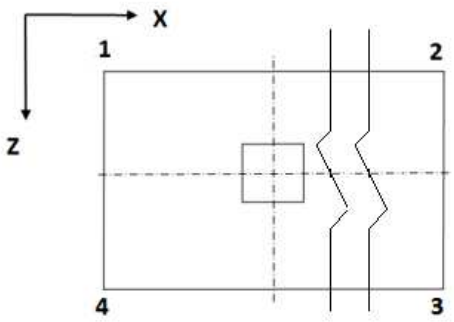
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**119.8776**	68.2359	18.4510	70.0927	0.000
29	93.0065	**128.4975**	38.8504	3.3594	0.000
23	54.6266	99.8589	**83.3722**	38.1398	0.000
36	49.4772	-4.0054	51.4346	**104.9173**	0.002

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

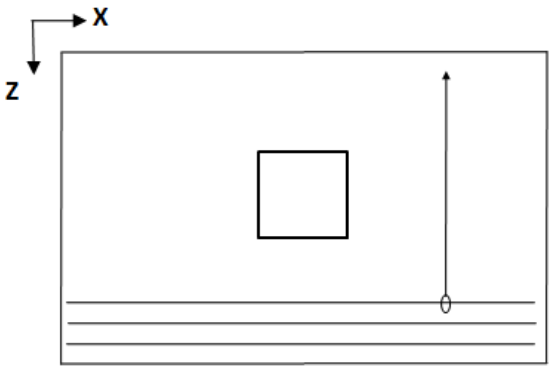
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**119.8776**	68.2359	18.4510	70.0927
29	93.0065	**128.4975**	38.8504	3.3594
23	54.6266	99.8589	**83.3722**	38.1398
36	49.4797	0.0000	51.4374	**104.9401**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.073	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.192	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 =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

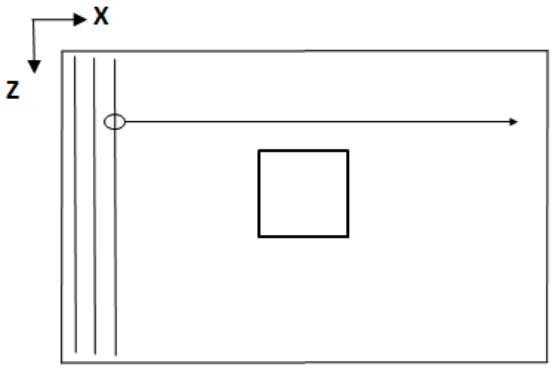
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.197	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.330	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

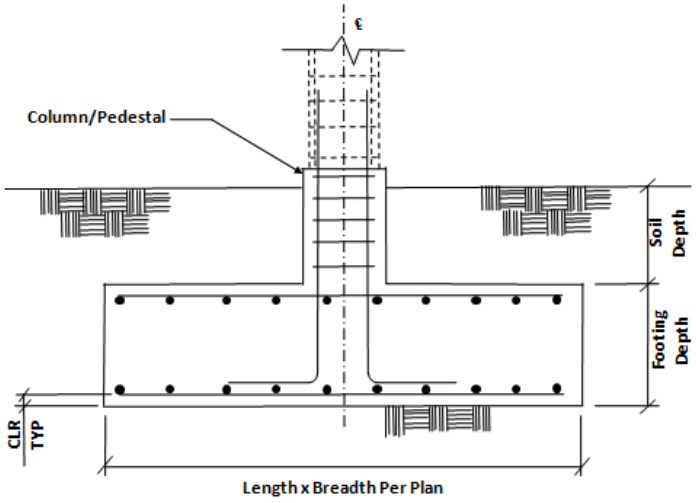
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

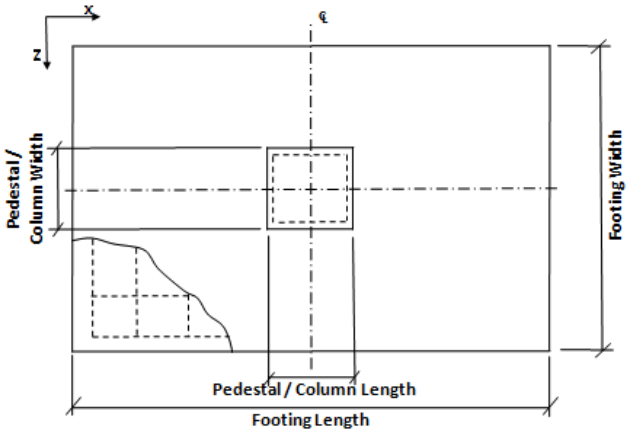
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 37



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	64.561	-2.563	3.516	-4.838	-1.230
23	65.289	0.315	4.551	-3.189	-5.595
24	62.883	-6.256	4.548	-3.203	4.308
25	63.610	1.112	2.524	-6.470	-6.783
26	61.204	-5.460	2.521	-6.485	3.119
27	66.418	-2.925	6.932	0.662	-0.725
28	65.700	-4.887	6.931	0.657	2.231
29	60.793	-0.258	0.141	-10.330	-4.707
30	60.075	-2.219	0.140	-10.335	-1.751
31	38.291	2.276	3.503	-0.715	-6.546
32	35.095	-6.453	3.499	-0.735	6.608

33	36.066	3.332	0.818	-5.063	-8.121
34	32.870	-5.398	0.813	-5.083	5.033
35	39.792	-2.033	6.669	4.404	-0.070
36	38.840	-4.632	6.668	4.399	3.847
37	31.369	-1.088	-2.353	-10.203	-1.443
38	32.320	1.511	-2.351	-10.197	-5.360

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	79.578	-3.060	4.186	-5.808	-1.464
40	80.316	2.409	6.177	-2.653	-9.768
41	75.738	-10.097	6.170	-2.681	9.076
42	77.105	3.932	2.300	-8.928	-12.041
43	72.527	-8.574	2.293	-8.956	6.803
44	82.460	-3.745	10.697	4.659	-0.520
45	81.087	-7.497	10.696	4.650	5.133
46	71.756	1.331	-2.225	-16.259	-8.098
47	70.383	-2.420	-2.227	-16.268	-2.445
48	57.265	3.150	5.179	-1.197	-9.420
49	52.687	-9.356	5.173	-1.225	9.424
50	54.054	4.673	1.302	-7.472	-11.693
51	49.476	-7.833	1.296	-7.501	7.151
52	59.409	-3.004	9.700	6.114	-0.172
53	58.036	-6.756	9.698	6.106	5.481
54	48.705	2.073	-3.223	-14.803	-7.750
55	47.332	-1.679	-3.225	-14.812	-2.097

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.581 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

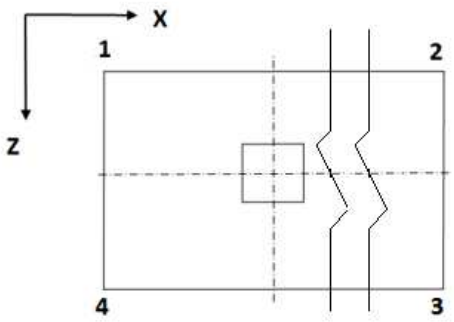
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**115.4498**	70.1001	19.5889	64.9386	0.000
29	92.7137	**134.3391**	41.6458	0.0204	0.000
23	52.3699	103.8068	**89.4205**	37.9836	0.000
36	43.3391	-5.9630	54.7352	**104.0373**	0.006

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

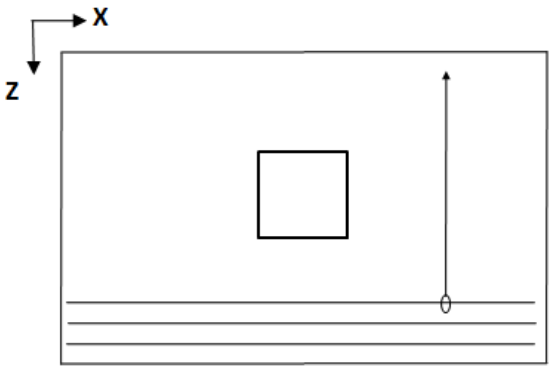
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**115.4498**	70.1001	19.5889	64.9386
29	92.7137	**134.3391**	41.6458	0.0204
23	52.3699	103.8068	**89.4205**	37.9836
36	43.3454	0.0000	54.7433	**104.1131**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	9.928	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.031	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 =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

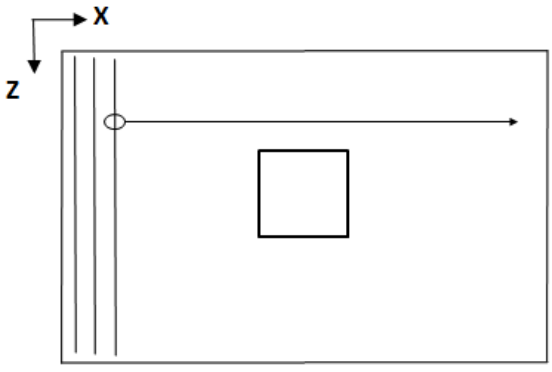
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.486	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.651	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00037	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

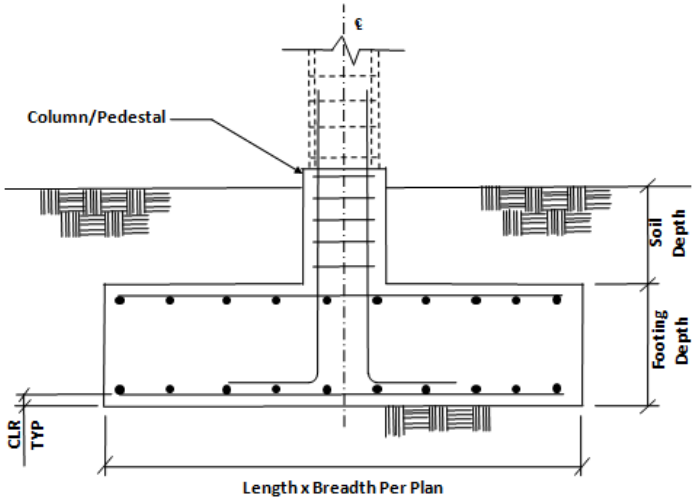
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

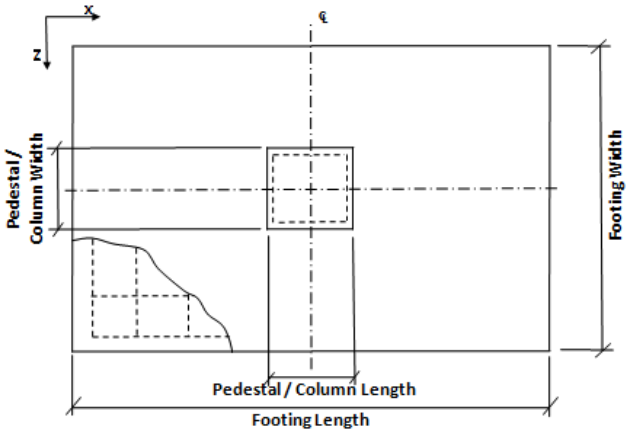
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 38



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	49.060	1.300	-4.078	4.234	0.144
23	49.606	4.805	-3.271	5.597	-6.168
24	44.689	-1.603	-3.061	5.920	5.424
25	50.985	4.113	-5.047	2.658	-4.959
26	46.068	-2.295	-4.838	2.981	6.633
27	46.261	3.372	-1.110	9.162	-3.523
28	44.793	1.459	-1.047	9.259	-0.063
29	50.881	1.052	-7.061	-0.681	0.527
30	49.413	-0.861	-6.999	-0.584	3.987
31	28.852	5.388	-1.351	4.403	-8.202
32	22.320	-3.124	-1.073	4.832	7.197

33	30.680	4.471	-3.706	0.510	-6.600
34	24.147	-4.041	-3.427	0.939	8.799
35	24.404	3.481	1.522	9.145	-4.684
36	22.459	0.947	1.605	9.273	-0.099
37	28.596	-2.134	-6.301	-3.802	5.281
38	30.541	0.400	-6.384	-3.930	0.696

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	60.830	1.630	-4.932	4.994	0.031
40	61.254	8.283	-3.375	7.627	-11.943
41	51.896	-3.911	-2.977	8.242	10.117
42	63.892	6.959	-6.773	2.008	-9.630
43	54.534	-5.235	-6.374	2.623	12.429
44	54.901	5.560	0.729	14.398	-6.919
45	52.094	1.902	0.848	14.583	-0.302
46	63.693	1.146	-10.598	-4.333	0.788
47	60.886	-2.512	-10.478	-4.148	7.406
48	43.110	7.770	-2.084	6.509	-11.738
49	33.752	-4.425	-1.686	7.124	10.321
50	45.747	6.445	-5.482	0.890	-9.426
51	36.389	-5.749	-5.084	1.505	12.633
52	36.757	5.047	2.019	13.280	-6.715
53	33.950	1.388	2.139	13.465	-0.097
54	45.549	0.632	-9.307	-5.450	0.992
55	42.742	-3.026	-9.188	-5.266	7.610

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.473 m^2$

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) = 1.100 m Governing Load Case : # 27

Width (W_2) = 1.100 m Governing Load Case : # 27

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)

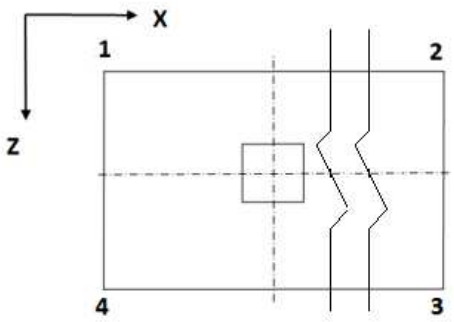
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**94.8259**	40.4785	-13.6848	40.6626	0.041
25	26.2077	**83.8997**	91.9407	34.2487	0.000
27	-5.5836	36.8187	**115.9230**	73.5207	0.004
24	58.9931	5.0376	48.7476	**102.7031**	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

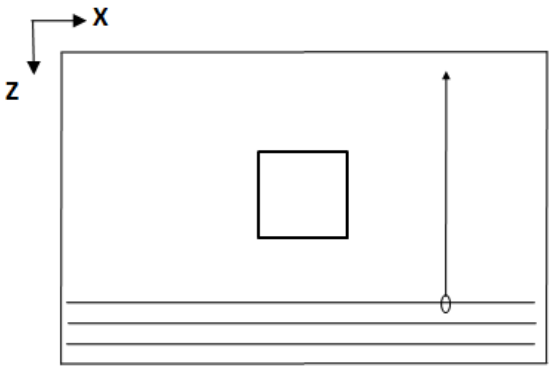
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
37	**95.5289**	40.2458	0.0000	40.4157
25	26.2077	**83.8997**	91.9407	34.2487
27	0.0000	36.8064	**115.9637**	73.5134
24	58.9931	5.0376	48.7476	**102.7031**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	9.624	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	10.694	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00032	
(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 =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

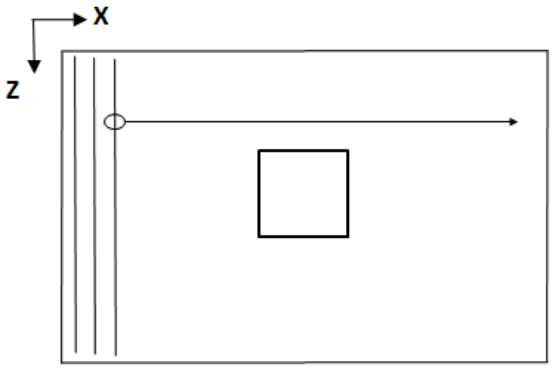
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	9.782	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	10.869	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00035	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

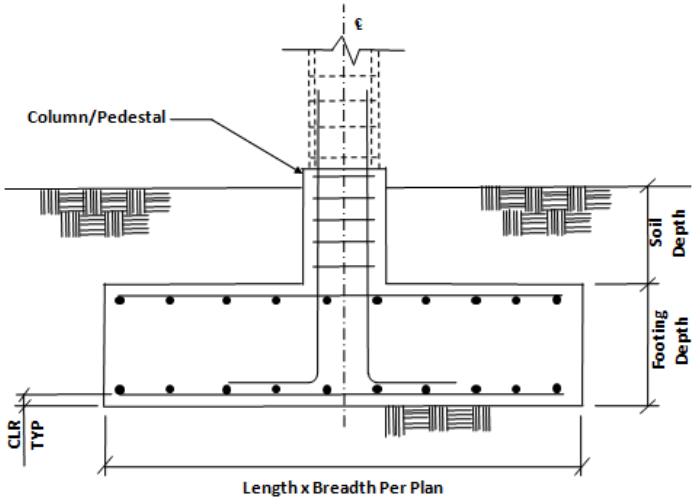
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

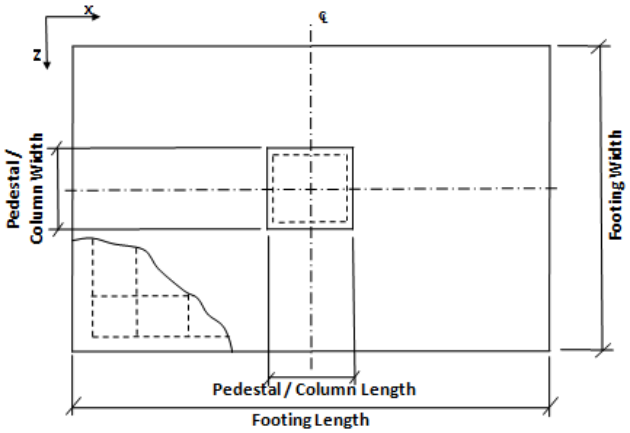
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 41



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	47.567	2.836	3.466	-5.002	3.479
23	49.333	5.140	4.314	-3.655	-0.595
24	45.601	-0.199	4.487	-3.350	8.857
25	48.231	5.814	2.495	-6.623	-1.769
26	44.500	0.475	2.668	-6.317	7.684
27	49.319	2.476	6.512	-0.061	4.098
28	48.205	0.882	6.564	0.030	6.920
29	45.628	4.732	0.418	-10.003	0.168
30	44.514	3.139	0.470	-9.911	2.990
31	30.186	4.732	3.229	-1.200	-3.257
32	25.230	-2.360	3.460	-0.794	9.299

33	28.726	5.625	0.819	-5.132	-4.811
34	23.770	-1.467	1.049	-4.726	7.745
35	30.167	1.190	6.152	3.579	2.985
36	28.692	-0.922	6.221	3.700	6.724
37	23.789	2.075	-1.874	-9.506	1.503
38	25.264	4.187	-1.942	-9.626	-2.236

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	58.122	3.450	4.119	-6.028	4.070
40	61.164	7.816	5.753	-3.443	-3.645
41	54.063	-2.343	6.083	-2.861	14.342
42	59.056	9.104	2.275	-9.119	-5.889
43	51.956	-1.055	2.605	-8.537	12.099
44	61.137	2.757	9.928	3.382	5.268
45	59.007	-0.291	10.027	3.557	10.665
46	54.113	7.051	-1.669	-15.536	-2.211
47	51.983	4.003	-1.570	-15.362	3.185
48	45.071	6.884	4.783	-1.898	-4.506
49	37.970	-3.275	5.113	-1.316	13.482
50	42.964	8.173	1.305	-7.573	-6.750
51	35.863	-1.987	1.635	-6.991	11.238
52	45.044	1.826	8.958	4.927	4.408
53	42.914	-1.222	9.057	5.102	9.804
54	38.020	6.120	-2.639	-13.991	-3.072
55	35.890	3.072	-2.540	-13.817	2.324

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.461 m^2$

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 : # 22

Width (W_2) = 1.000 m Governing Load Case : # 22

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)

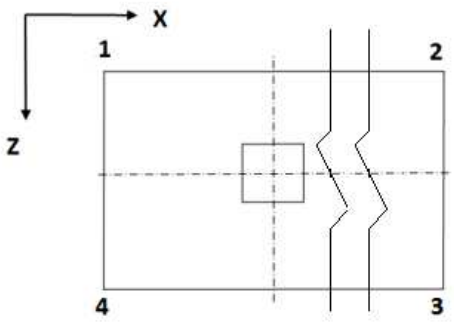
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.336 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	**138.6410**	48.4308	-16.1704	74.0397	0.022
38	81.6315	**126.0462**	2.3686	-42.0461	0.160
31	17.8644	76.8201	**75.9793**	17.0236	0.000
36	52.4419	-32.1186	38.4126	**122.9732**	0.086

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

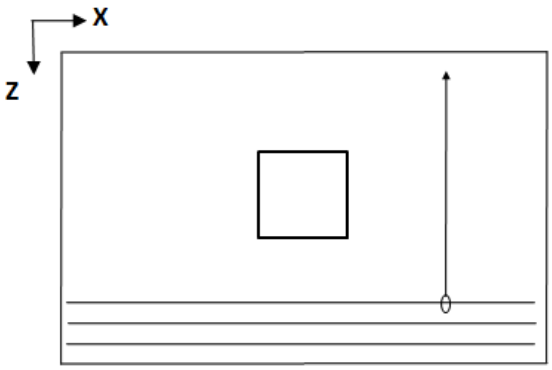
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**139.2106**	48.2359	0.0000	73.8772
38	83.1949	**141.1602**	0.0000	0.0000
31	17.8644	76.8201	**75.9793**	17.0236
36	52.8513	0.0000	38.5285	**129.0742**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	7.502	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.335	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00027	
(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 =	$\rho \times W \times d_{eff}$ =	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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	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	

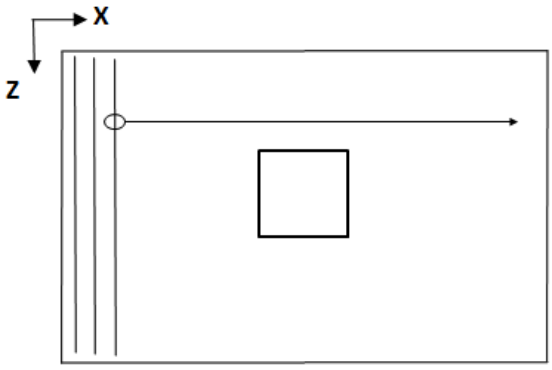
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	7.742	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.602	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 =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.250	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}

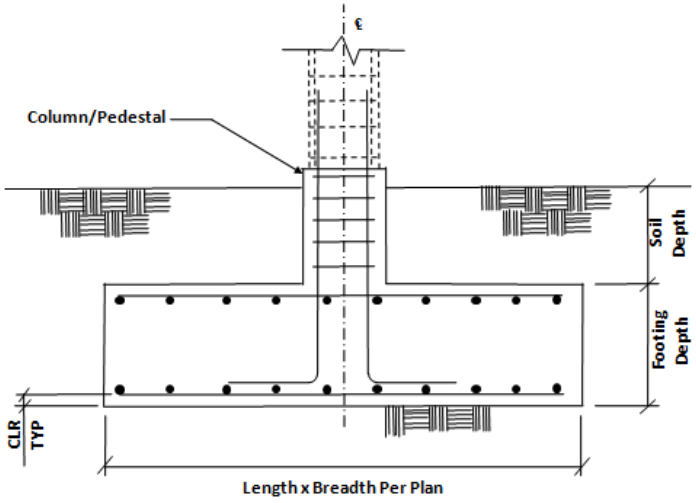
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

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

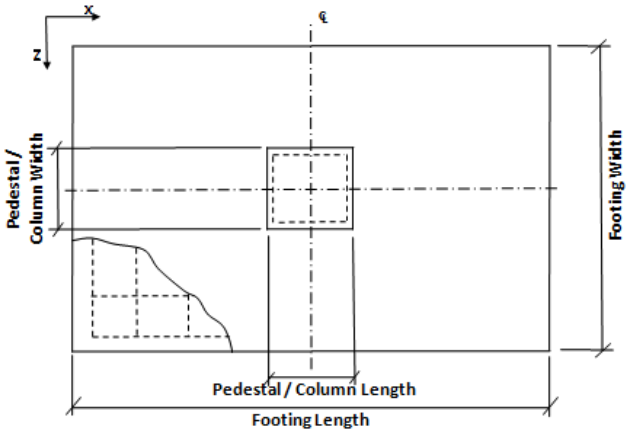
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 43



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	78.726	-0.191	0.048	-0.898	0.395
23	78.398	1.938	1.144	0.868	-4.935
24	75.589	-2.329	1.139	0.895	5.657
25	77.898	1.977	-1.044	-2.553	-4.931
26	75.089	-2.290	-1.049	-2.526	5.661
27	78.000	0.396	3.714	4.898	-1.224
28	77.162	-0.878	3.712	4.906	1.937
29	76.325	0.526	-3.617	-6.564	-1.211
30	75.487	-0.748	-3.618	-6.556	1.950
31	44.674	2.731	1.481	1.876	-6.878
32	40.943	-2.938	1.475	1.912	7.192

33	44.011	2.782	-1.418	-2.657	-6.873
34	40.280	-2.886	-1.424	-2.622	7.198
35	44.145	0.680	4.898	7.234	-1.943
36	43.034	-1.008	4.896	7.245	2.246
37	40.809	-0.836	-4.841	-7.980	2.263
38	41.920	0.852	-4.839	-7.991	-1.926

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	97.644	-0.254	0.057	-1.188	0.526
40	96.036	3.806	2.154	2.224	-9.634
41	90.691	-4.314	2.145	2.275	10.523
42	95.080	3.880	-2.031	-4.320	-9.626
43	89.734	-4.240	-2.040	-4.269	10.530
44	95.281	0.878	7.033	9.876	-2.587
45	93.677	-1.558	7.031	9.891	3.460
46	92.093	1.124	-6.916	-11.936	-2.563
47	90.490	-1.312	-6.919	-11.921	3.484
48	66.866	3.906	2.140	2.687	-9.842
49	61.521	-4.214	2.131	2.738	10.315
50	65.910	3.980	-2.045	-3.857	-9.835
51	60.565	-4.140	-2.054	-3.806	10.322
52	66.111	0.978	7.019	10.339	-2.796
53	64.508	-1.458	7.017	10.354	3.251
54	62.923	1.224	-6.930	-11.473	-2.771
55	61.320	-1.212	-6.933	-11.458	3.276

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.667m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

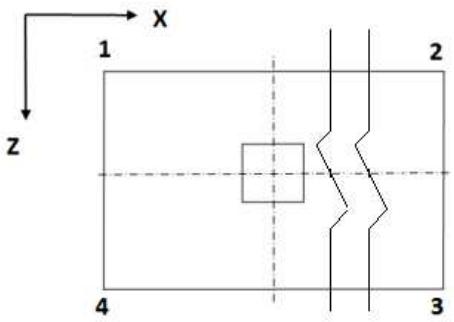
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**124.5585**	104.6127	34.0881	54.0339	0.000
29	109.0223	**121.6027**	51.0103	38.4299	0.000
27	47.3175	59.6067	**115.4840**	103.1948	0.000
28	62.8537	42.6167	98.5618	**118.7988**	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

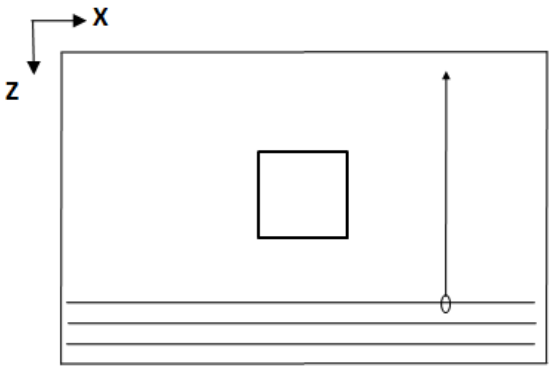
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**124.5585**	104.6127	34.0881	54.0339
29	109.0223	**121.6027**	51.0103	38.4299
27	47.3175	59.6067	**115.4840**	103.1948
28	62.8537	42.6167	98.5618	**118.7988**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	10.408	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.564	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

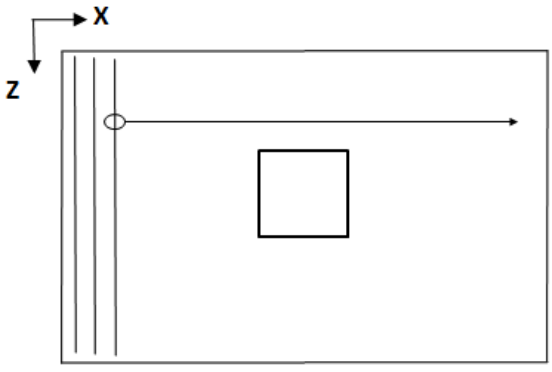
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	11.064	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.293	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00040	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	ρ≤ ρ_{min}	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

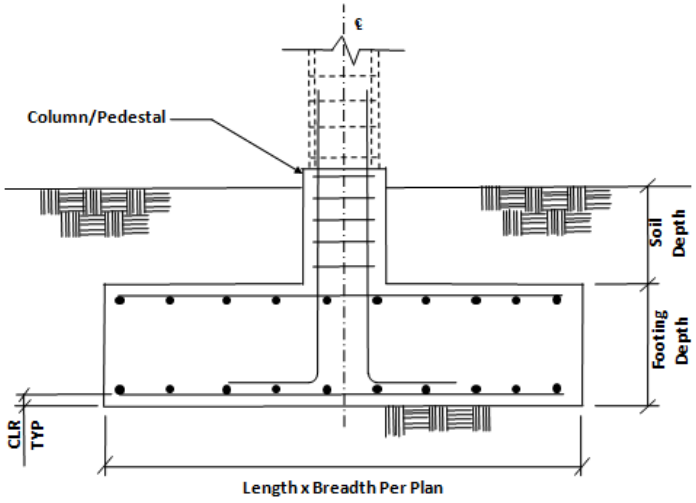
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

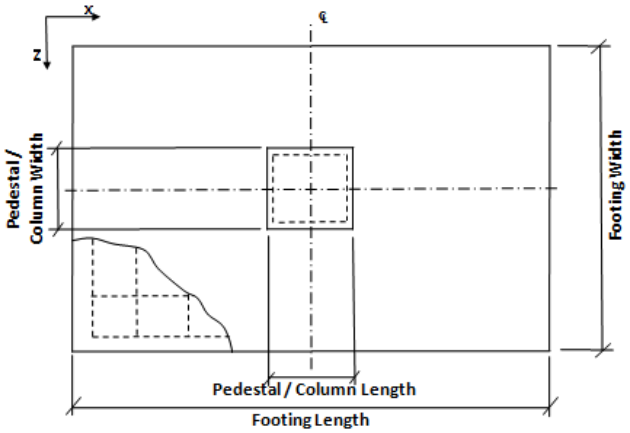
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 45



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	78.655	0.295	0.013	-0.961	-0.544
23	75.270	2.403	1.032	0.732	-5.831
24	78.045	-1.873	1.050	0.729	4.775
25	75.311	2.414	-1.019	-2.502	-5.774
26	78.086	-1.862	-1.001	-2.505	4.832
27	76.195	0.890	3.449	4.531	-2.178
28	77.024	-0.386	3.454	4.530	0.988
29	76.332	0.928	-3.423	-6.303	-1.987
30	77.161	-0.349	-3.418	-6.304	1.179
31	40.578	2.952	1.362	1.747	-7.302
32	44.264	-2.728	1.386	1.742	6.787

33	40.632	2.967	-1.356	-2.538	-7.226
34	44.318	-2.713	-1.332	-2.543	6.863
35	41.808	0.940	4.575	6.799	-2.444
36	42.906	-0.751	4.582	6.797	1.751
37	43.088	-0.701	-4.546	-7.595	2.005
38	41.990	0.990	-4.553	-7.593	-2.190

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	97.550	0.392	0.010	-1.272	-0.724
40	90.125	4.392	1.962	2.003	-10.764
41	95.406	-3.745	1.996	1.996	9.420
42	90.203	4.414	-1.961	-4.183	-10.654
43	95.484	-3.724	-1.927	-4.189	9.529
44	91.882	1.519	6.551	9.217	-3.827
45	93.466	-0.922	6.561	9.215	2.228
46	92.143	1.591	-6.526	-11.401	-3.462
47	93.727	-0.850	-6.516	-11.403	2.593
48	60.992	4.237	1.966	2.499	-10.476
49	66.274	-3.901	2.001	2.492	9.708
50	61.070	4.258	-1.957	-3.686	-10.367
51	66.352	-3.879	-1.922	-3.693	9.817
52	62.749	1.364	6.555	9.713	-3.539
53	64.334	-1.078	6.566	9.711	2.516
54	63.010	1.435	-6.521	-10.905	-3.175
55	64.595	-1.006	-6.511	-10.907	2.880

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.666 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

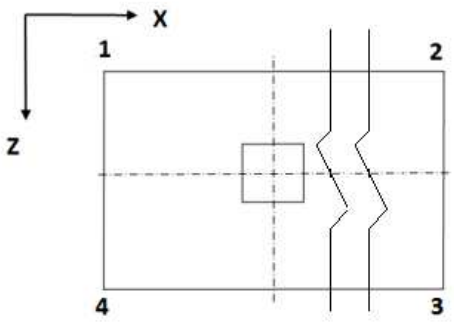
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**120.3848**	108.6515	41.0291	52.7623	0.000
29	103.4174	**124.2572**	56.6270	35.7873	0.000
27	42.8171	65.2638	**117.0007**	94.5540	0.000
28	59.7845	49.6581	101.4027	**111.5291**	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

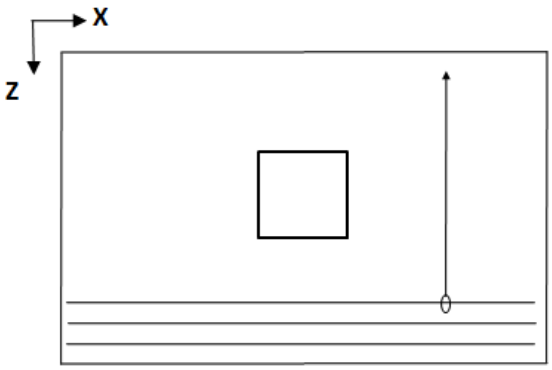
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**120.3848**	108.6515	41.0291	52.7623
29	103.4174	**124.2572**	56.6270	35.7873
27	42.8171	65.2638	**117.0007**	94.5540
28	59.7845	49.6581	101.4027	**111.5291**

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 # 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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.390	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.545	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

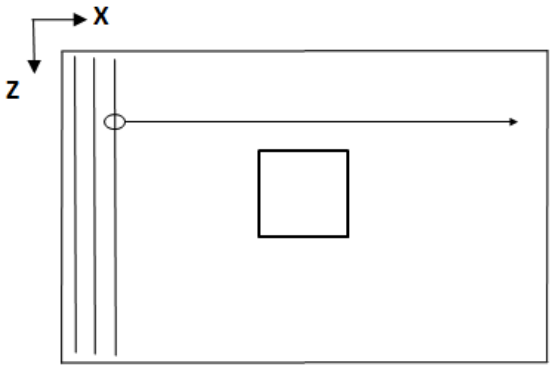
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.987	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.208	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00039	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00029	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

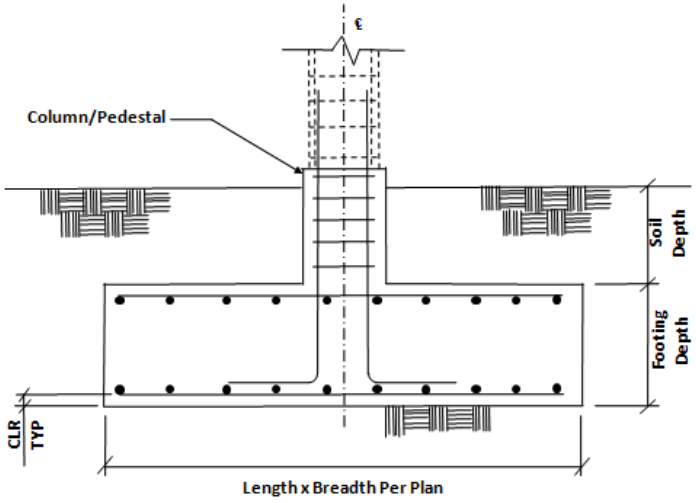
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

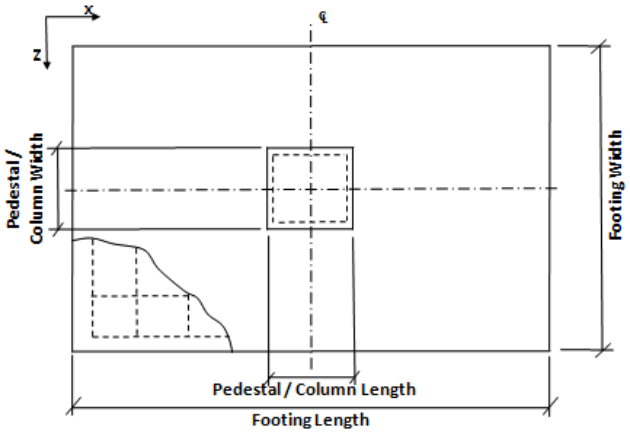
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 49



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	56.189	0.360	-5.109	-9.173	-0.004
23	53.526	4.386	-4.000	-6.809	-6.488
24	51.905	-2.857	-3.840	-6.573	5.231
25	54.054	3.649	-5.573	-10.302	-5.278
26	52.433	-3.594	-5.412	-10.066	6.441
27	52.338	2.711	-2.095	-2.622	-3.800
28	51.854	0.549	-2.047	-2.552	-0.302
29	54.106	0.243	-7.365	-14.323	0.255
30	53.622	-1.919	-7.317	-14.253	3.753
31	26.738	5.601	-1.162	-1.581	-8.634
32	24.584	-4.020	-0.949	-1.267	6.932

33	27.437	4.625	-3.246	-6.209	-7.030
34	25.284	-4.996	-3.034	-5.895	8.536
35	25.157	3.374	1.370	3.987	-5.060
36	24.516	0.509	1.434	4.080	-0.425
37	26.865	-2.769	-5.566	-11.463	4.962
38	27.506	0.096	-5.629	-11.557	0.327

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	72.562	0.374	-6.776	-12.185	0.026
40	65.897	8.057	-4.457	-7.304	-12.328
41	62.812	-5.727	-4.152	-6.855	9.972
42	66.907	6.648	-7.465	-13.984	-10.013
43	63.822	-7.136	-7.160	-13.535	12.287
44	63.640	4.876	-0.840	0.647	-7.224
45	62.714	0.741	-0.749	0.782	-0.533
46	67.005	0.180	-10.868	-21.621	0.493
47	66.079	-3.955	-10.777	-21.486	7.183
48	40.054	8.050	-1.795	-2.492	-12.381
49	36.969	-5.734	-1.490	-2.042	9.919
50	41.063	6.641	-4.803	-9.172	-10.066
51	37.978	-7.143	-4.499	-8.723	12.234
52	37.796	4.869	1.821	5.459	-7.277
53	36.871	0.734	1.913	5.594	-0.587
54	41.161	0.173	-8.206	-16.808	0.440
55	40.236	-3.962	-8.115	-16.673	7.130

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.509 m^2$

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) = 1.200 m Governing Load Case : # 25

Width (W_2) = 1.200 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)

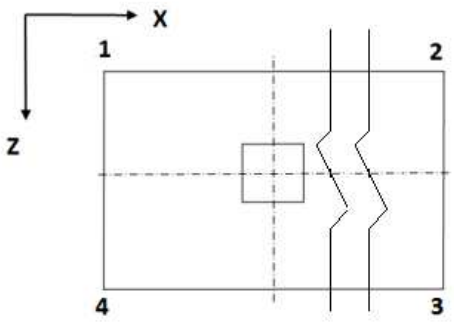
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**128.0751**	97.3470	-19.4177	11.3104	0.074
25	74.4127	**119.9328**	34.8450	-10.6751	0.021
35	-2.6175	40.7210	**71.7400**	28.4016	0.002
32	68.6745	10.7604	-0.3470	**57.5671**	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

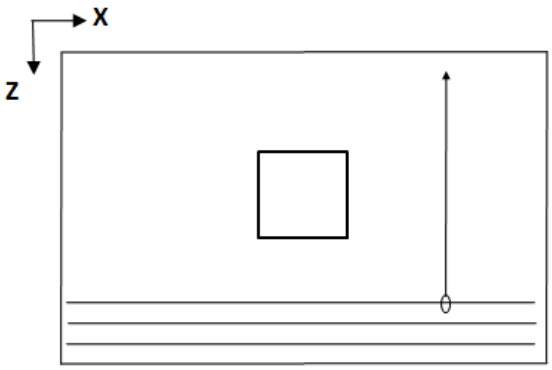
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**129.5321**	97.0243	0.0000	10.1747
25	74.2481	**120.0845**	34.6526	0.0000
35	0.0000	40.7187	**71.7506**	28.3981
32	68.6746	10.7604	0.0000	**57.5672**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	11.400	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.666	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00035	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

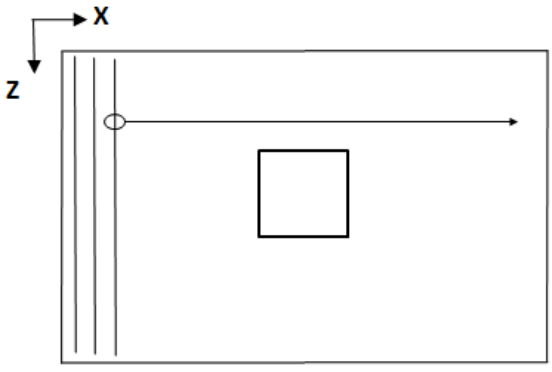
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	14.201	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	15.779	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00047	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00035	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

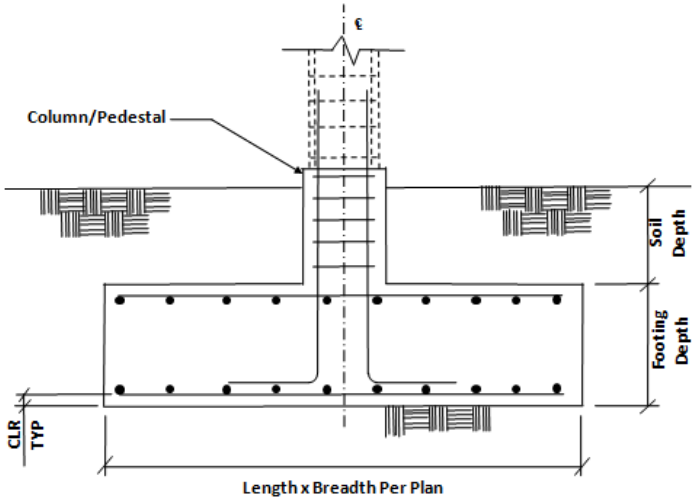
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

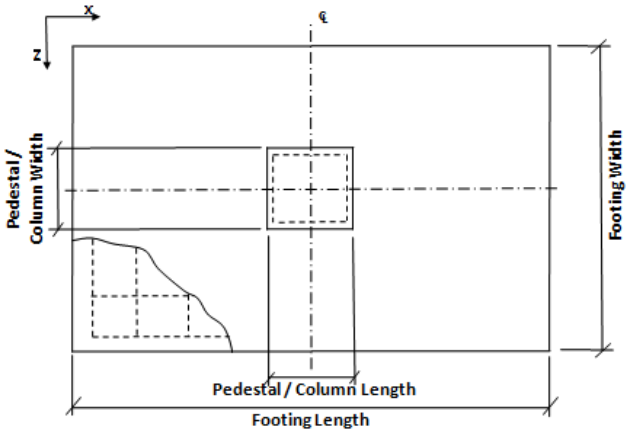
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 51



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	58.843	0.656	6.346	10.226	-0.476
23	57.561	3.372	6.690	11.226	-4.781
24	56.080	-2.724	6.479	10.838	5.014
25	56.939	4.085	5.192	7.966	-5.977
26	55.457	-2.011	4.981	7.578	3.817
27	57.773	0.396	8.377	14.921	0.061
28	57.331	-1.424	8.314	14.805	2.984
29	55.688	2.785	3.357	3.999	-3.948
30	55.245	0.965	3.294	3.883	-1.025
31	31.101	4.029	3.716	6.574	-6.012
32	29.133	-4.069	3.435	6.059	6.998

33	30.277	4.974	1.730	2.254	-7.598
34	28.308	-3.124	1.450	1.739	5.412
35	31.383	0.071	5.958	11.488	0.426
36	30.797	-2.340	5.875	11.334	4.300
37	28.027	0.834	-0.793	-3.174	-1.026
38	28.613	3.245	-0.709	-3.021	-4.899

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	74.346	0.748	8.431	13.591	-0.562
40	70.750	5.925	8.840	15.099	-8.750
41	67.930	-5.676	8.439	14.360	9.887
42	69.559	7.290	5.975	8.864	-11.039
43	66.740	-4.312	5.573	8.125	7.599
44	71.152	0.274	12.043	22.115	0.443
45	70.306	-3.207	11.922	21.893	6.034
46	67.183	4.821	2.491	1.331	-7.186
47	66.337	1.340	2.371	1.109	-1.595
48	46.563	5.797	5.508	9.722	-8.624
49	43.743	-5.804	5.106	8.983	10.014
50	45.372	7.161	2.642	3.487	-10.913
51	42.552	-4.440	2.241	2.748	7.725
52	46.965	0.145	8.710	16.738	0.569
53	46.119	-3.335	8.590	16.516	6.160
54	42.996	4.692	-0.841	-4.046	-7.060
55	42.150	1.212	-0.962	-4.268	-1.468

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.528 m^2$

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) = 1.200 m Governing Load Case : # 23

Width (W_2) = 1.200 m Governing Load Case : # 23

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)

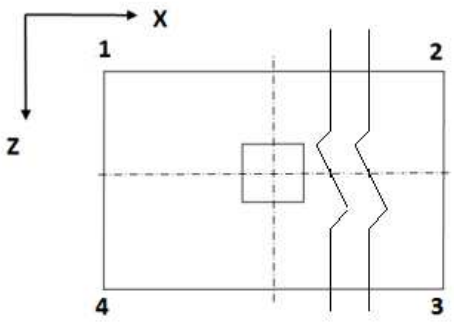
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**51.5398**	6.3593	21.9597	67.1403	0.000
38	27.3567	**69.2670**	46.5656	4.6552	0.000
23	-10.7430	30.6517	**124.8720**	83.4773	0.021
28	7.4879	-16.6988	106.3210	**130.5077**	0.069

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

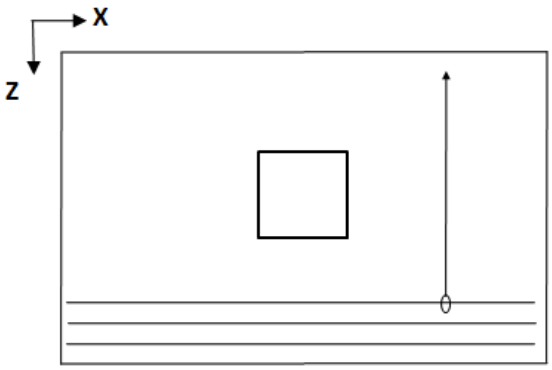
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**51.5398**	6.3593	21.9597	67.1403
38	27.3567	**69.2670**	46.5656	4.6552
23	0.0000	30.5638	**125.1203**	83.4229
28	7.2956	0.0000	106.6646	**132.0206**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	11.183	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.426	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

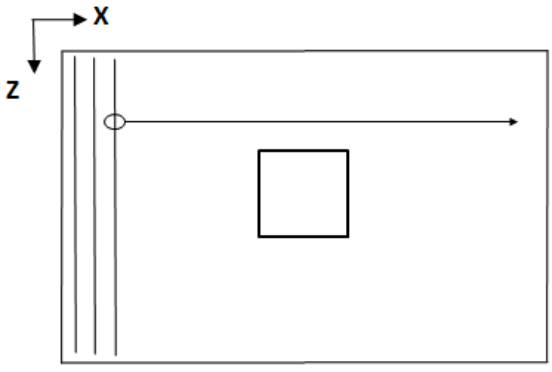
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	16.875	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	18.749	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00055	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00041	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

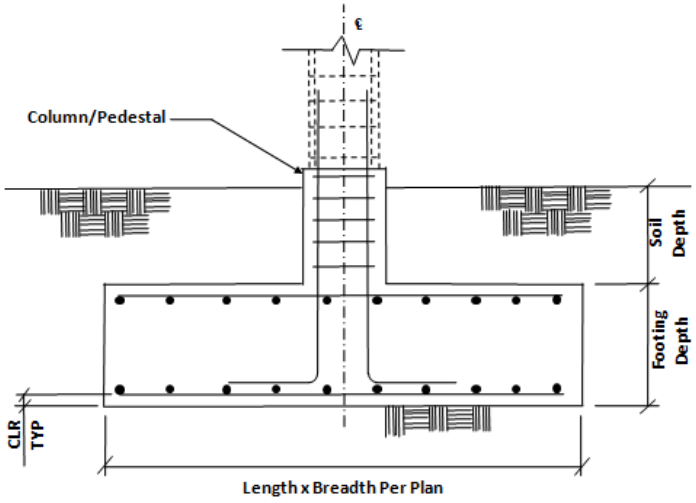
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

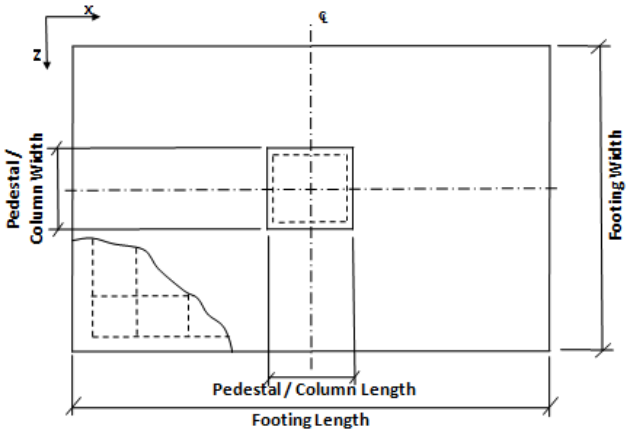
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 53



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	53.778	-0.410	-4.679	-8.575	0.154
23	50.070	3.667	-3.390	-5.847	-6.366
24	50.584	-3.720	-3.456	-5.957	5.444
25	50.935	2.915	-5.161	-9.812	-5.143
26	51.449	-4.472	-5.227	-9.922	6.668
27	49.234	1.959	-1.332	-1.226	-3.661
28	49.388	-0.246	-1.352	-1.259	-0.136
29	52.132	-0.559	-7.265	-14.510	0.437
30	52.286	-2.764	-7.285	-14.543	3.962
31	24.109	5.176	-0.702	-0.789	-8.570
32	24.792	-4.636	-0.790	-0.934	7.118

33	25.255	4.180	-3.049	-6.043	-6.949
34	25.938	-5.632	-3.137	-6.189	8.739
35	22.997	2.906	2.034	5.356	-4.973
36	23.200	-0.016	2.008	5.313	-0.302
37	27.050	-3.362	-5.873	-12.334	5.142
38	26.846	-0.440	-5.847	-12.290	0.471

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	69.363	-0.504	-6.207	-11.394	0.190
40	60.803	7.261	-3.562	-5.841	-12.225
41	61.781	-6.796	-3.688	-6.050	10.250
42	62.457	5.823	-6.949	-13.425	-9.885
43	63.435	-8.233	-7.075	-13.634	12.589
44	59.215	4.019	0.346	2.934	-7.088
45	59.509	-0.198	0.308	2.871	-0.346
46	64.730	-0.774	-10.945	-22.346	0.710
47	65.023	-4.991	-10.983	-22.409	7.453
48	36.219	7.405	-1.122	-1.337	-12.281
49	37.197	-6.652	-1.248	-1.545	10.194
50	37.873	5.967	-4.509	-8.921	-9.941
51	38.851	-8.090	-4.636	-9.129	12.534
52	34.631	4.163	2.785	7.438	-7.144
53	34.924	-0.054	2.747	7.376	-0.402
54	40.145	-0.630	-8.505	-17.842	0.655
55	40.439	-4.847	-8.543	-17.904	7.397

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.492 m^2$

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) = 1.200 m Governing Load Case : # 26

Width (W_2) = 1.200 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)

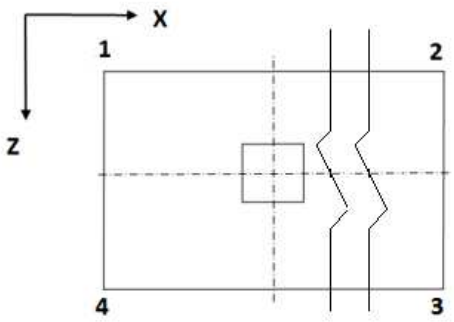
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**129.8709**	95.6340	-23.0696	11.1673	0.094
25	71.4076	**114.2066**	33.5187	-9.2804	0.018
35	-8.8093	32.7899	**74.9321**	33.3329	0.035
32	68.8619	8.1625	-0.2467	**60.4527**	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

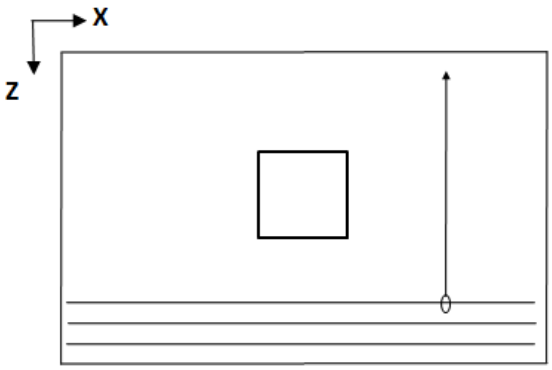
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**132.0814**	95.1272	0.0000	9.3625
25	71.2881	**114.3187**	33.3784	0.0000
35	0.0000	32.6893	**75.2510**	33.2241
32	68.8620	8.1624	0.0000	**60.4528**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	11.072	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.303	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

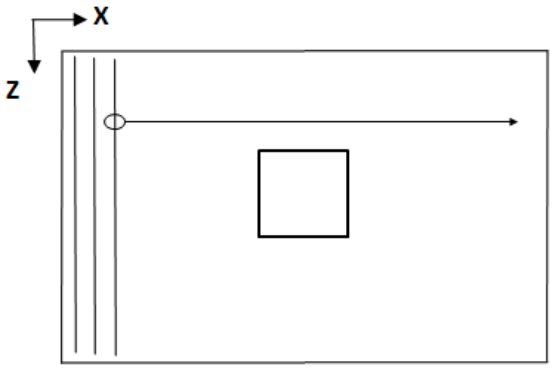
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	14.290	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	15.878	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00047	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00035	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m	
Try bar size # 10	Area of one bar =	78.542	mm2	
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10		

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

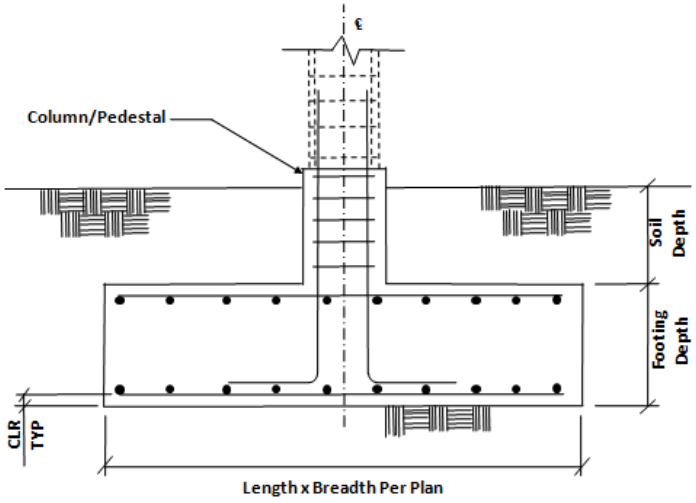
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

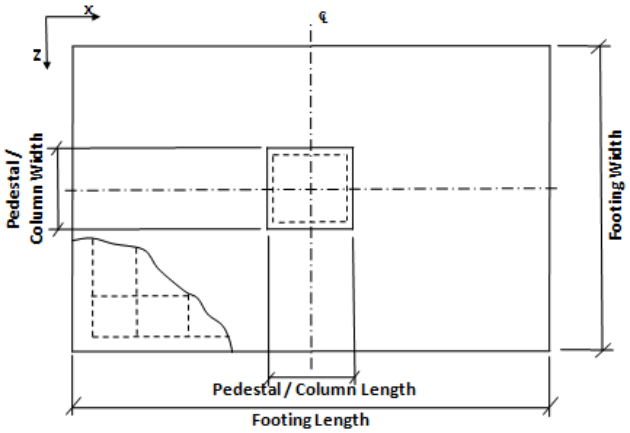
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 55



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	56.811	0.666	5.713	9.028	0.106
23	54.836	3.463	6.041	10.060	-4.180
24	55.283	-2.844	6.105	10.170	5.588
25	53.991	4.190	4.404	6.431	-5.379
26	54.439	-2.117	4.468	6.541	4.389
27	55.985	0.396	7.987	14.363	0.655
28	56.119	-1.487	8.006	14.395	3.570
29	53.155	2.833	2.503	2.206	-3.362
30	53.289	0.950	2.522	2.239	-0.446
31	29.131	4.123	3.369	6.003	-5.634
32	29.726	-4.255	3.453	6.149	7.342

33	28.012	5.087	1.200	1.195	-7.222
34	28.607	-3.291	1.284	1.341	5.753
35	30.660	0.045	5.956	11.725	0.796
36	30.837	-2.450	5.982	11.768	4.659
37	27.078	0.787	-1.303	-4.380	-0.676
38	26.901	3.282	-1.328	-4.424	-4.539

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	71.652	0.789	7.590	11.996	0.129
40	66.816	6.110	7.994	13.617	-8.022
41	67.668	-5.892	8.114	13.826	10.567
42	65.200	7.502	4.863	6.677	-10.315
43	66.053	-4.500	4.984	6.886	8.274
44	68.999	0.287	11.689	21.787	1.159
45	69.255	-3.314	11.725	21.850	6.736
46	63.614	4.924	1.253	-1.346	-6.484
47	63.870	1.324	1.289	-1.284	-0.907
48	43.685	5.929	4.995	8.874	-8.058
49	44.537	-6.073	5.116	9.083	10.531
50	42.069	7.320	1.865	1.934	-10.351
51	42.922	-4.682	1.985	2.143	8.238
52	45.868	0.105	8.690	17.044	1.123
53	46.124	-3.495	8.726	17.106	6.700
54	40.483	4.743	-1.745	-6.090	-6.520
55	40.738	1.142	-1.709	-6.027	-0.943

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.514 m^2$

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) = 1.200 m Governing Load Case : # 24

Width (W_2) = 1.200 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)

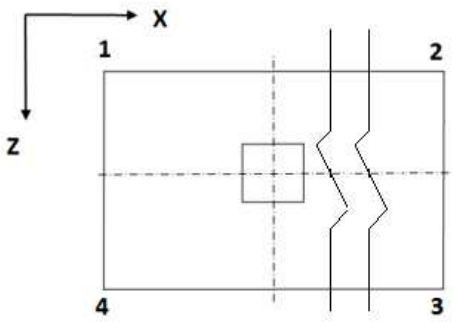
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**54.7162**	6.7619	19.1977	67.1520	0.000
38	32.9955	**72.4964**	38.5490	-0.9519	0.000
23	-5.8257	31.6208	**116.1687**	78.7222	0.009
28	10.5528	-17.8564	101.5727	**129.9818**	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

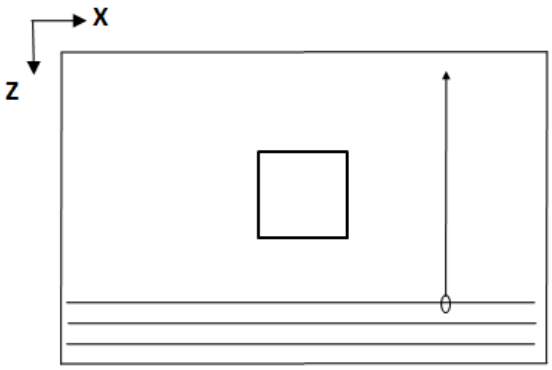
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**54.7162**	6.7619	19.1977	67.1520
38	32.9954	**72.4966**	38.5490	0.0000
23	0.0000	31.6052	**116.2174**	78.7139
28	10.3907	0.0000	101.9112	**131.6393**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.574	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.749	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00032	
(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 =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

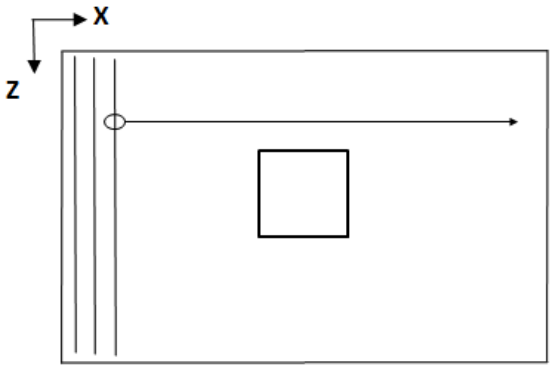
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	16.925	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	18.805	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00056	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00041	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

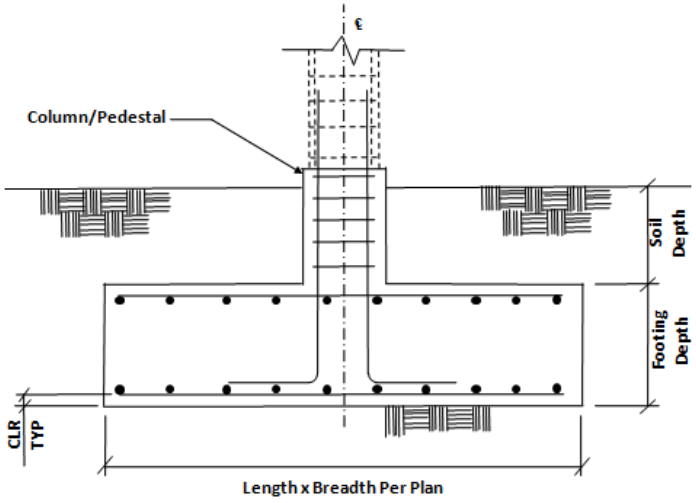
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

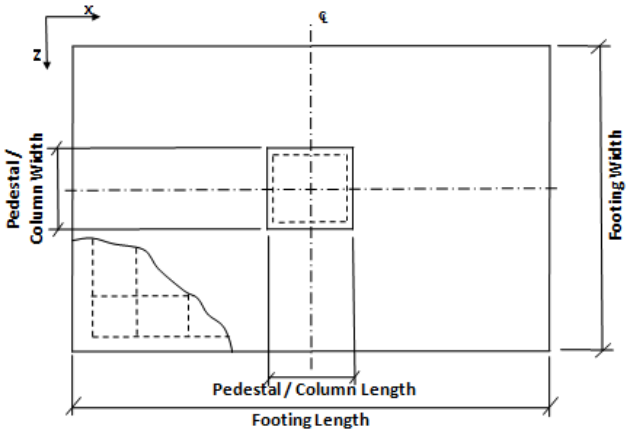
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 57



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	53.830	0.484	-4.684	-8.584	-0.096
23	50.580	4.547	-3.464	-5.975	-6.612
24	50.257	-2.840	-3.417	-5.898	5.199
25	51.359	3.796	-5.211	-9.888	-5.386
26	51.036	-3.590	-5.164	-9.812	6.425
27	49.551	2.837	-1.395	-1.351	-3.911
28	49.455	0.633	-1.381	-1.328	-0.385
29	52.161	0.324	-7.247	-14.459	0.198
30	52.064	-1.881	-7.233	-14.436	3.723
31	24.743	5.679	-0.796	-0.951	-8.709
32	24.314	-4.132	-0.733	-0.849	6.980

33	25.775	4.685	-3.110	-6.136	-7.084
34	25.346	-5.126	-3.047	-6.034	8.605
35	23.375	3.407	1.956	5.199	-5.116
36	23.247	0.485	1.974	5.229	-0.445
37	26.714	-2.853	-5.799	-12.184	5.013
38	26.841	0.068	-5.817	-12.214	0.341

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	69.432	0.590	-6.214	-11.406	-0.119
40	61.740	8.322	-3.700	-6.080	-12.524
41	61.126	-5.734	-3.609	-5.933	9.952
42	63.230	6.887	-7.040	-13.564	-10.178
43	62.616	-7.169	-6.950	-13.417	12.297
44	59.787	5.076	0.229	2.702	-7.394
45	59.603	0.860	0.257	2.746	-0.651
46	64.753	0.293	-10.906	-22.243	0.425
47	64.569	-3.924	-10.879	-22.199	7.167
48	37.129	8.160	-1.257	-1.570	-12.488
49	36.514	-5.895	-1.167	-1.424	9.988
50	38.619	6.725	-4.598	-9.054	-10.142
51	38.004	-7.330	-4.507	-8.908	12.333
52	35.175	4.915	2.672	7.212	-7.358
53	34.991	0.698	2.699	7.256	-0.615
54	40.142	0.132	-8.464	-17.734	0.460
55	39.957	-4.085	-8.437	-17.690	7.203

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.493m^2$

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) = 1.200 m Governing Load Case : # 25

Width (W_2) = 1.200 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)

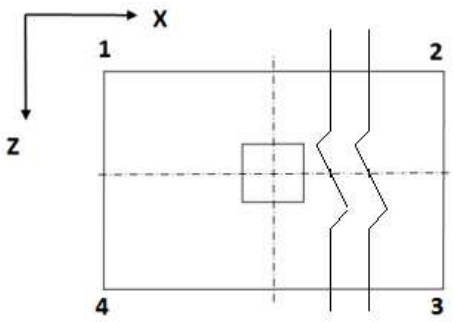
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**127.3782**	96.9491	-20.8841	9.5450	0.085
25	70.1110	**116.7393**	35.4028	-11.2255	0.023
35	-9.0087	34.8003	**75.6562**	31.8472	0.035
32	67.0738	8.5557	0.8778	**59.3960**	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

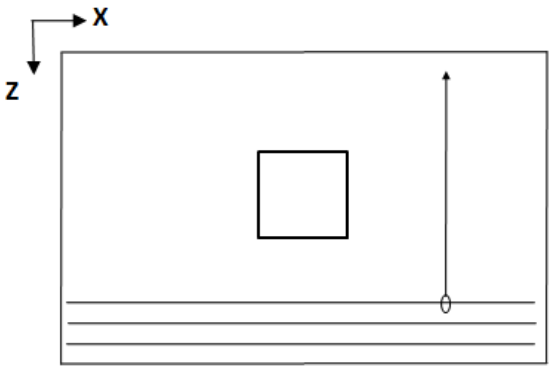
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**129.1866**	96.5595	0.0000	8.0232
25	69.9134	**116.9219**	35.1742	0.0000
35	0.0000	34.6966	**75.9894**	31.7288
32	67.0738	8.5557	0.8778	**59.3960**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	11.165	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.406	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

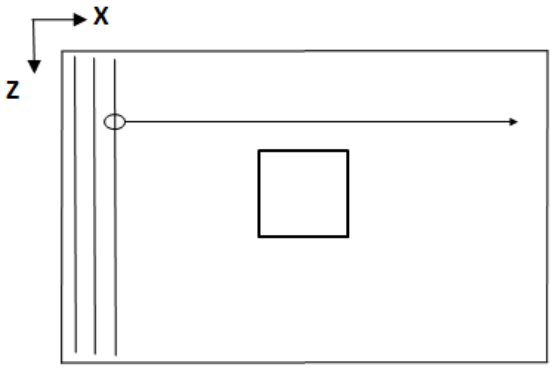
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	14.215	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	15.794	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00047	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00035	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

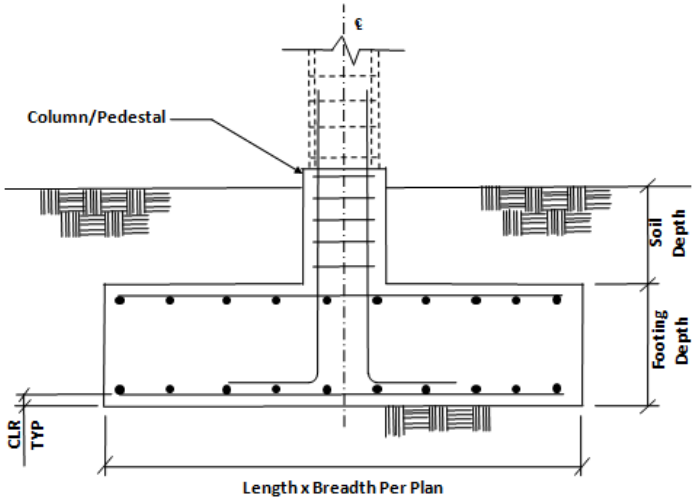
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

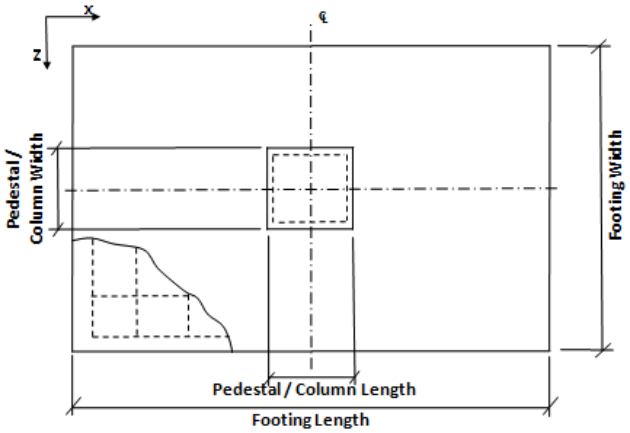
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 59



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	56.862	-0.391	5.720	9.041	0.069
23	55.222	2.392	6.105	10.166	-4.211
24	54.937	-3.915	6.052	10.070	5.556
25	54.432	3.122	4.470	6.555	-5.415
26	54.147	-3.184	4.417	6.459	4.352
27	56.051	-0.678	8.008	14.375	0.630
28	55.966	-2.561	7.993	14.347	3.545
29	53.403	1.768	2.529	2.279	-3.405
30	53.318	-0.114	2.513	2.250	-0.489
31	29.603	3.458	3.448	6.133	-5.645
32	29.225	-4.920	3.378	6.006	7.329

33	28.556	4.426	1.281	1.349	-7.241
34	28.178	-3.952	1.211	1.221	5.734
35	30.706	-0.625	5.979	11.731	0.792
36	30.593	-3.119	5.958	11.693	4.655
37	27.075	0.130	-1.320	-4.376	-0.703
38	27.188	2.625	-1.299	-4.338	-4.567

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	71.720	-0.461	7.599	12.013	0.081
40	67.520	4.829	8.111	13.811	-8.058
41	66.978	-7.172	8.010	13.628	10.529
42	66.008	6.226	4.983	6.905	-10.361
43	65.466	-5.776	4.882	6.722	8.226
44	69.094	-1.001	11.725	21.804	1.134
45	68.931	-4.601	11.695	21.749	6.710
46	64.054	3.655	1.298	-1.216	-6.543
47	63.892	0.054	1.268	-1.271	-0.966
48	44.363	4.932	5.109	9.060	-8.075
49	43.821	-7.070	5.008	8.877	10.512
50	42.851	6.329	1.981	2.154	-10.378
51	42.309	-5.673	1.880	1.971	8.209
52	45.937	-0.898	8.723	17.053	1.117
53	45.774	-4.499	8.693	16.998	6.693
54	40.897	3.757	-1.704	-5.967	-6.560
55	40.735	0.157	-1.734	-6.022	-0.984

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.514 m^2$

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) = 1.200 m Governing Load Case : # 24

Width (W_2) = 1.200 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)

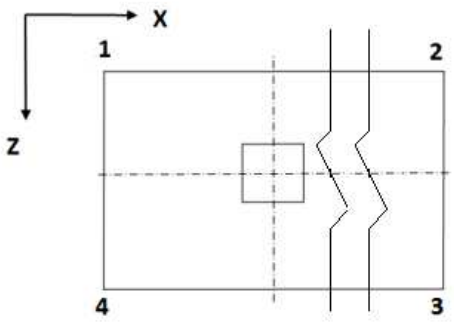
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**55.6604**	6.2348	17.6575	67.0832	0.000
38	33.5679	**71.6604**	38.3755	0.2830	0.000
23	-4.8091	30.2507	**115.6890**	80.6292	0.005
28	11.8494	-18.9938	100.0638	**130.9070**	0.071

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

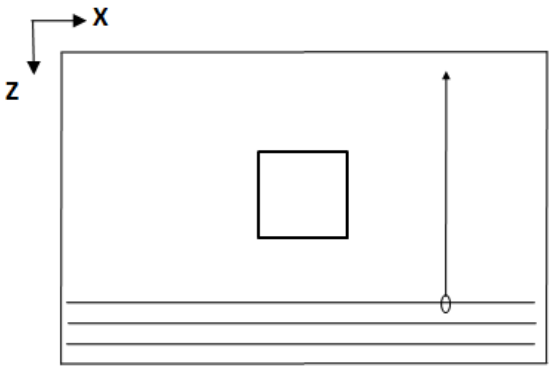
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**55.6604**	6.2348	17.6575	67.0832
38	33.5679	**71.6604**	38.3755	0.2830
23	0.0000	30.2413	**115.7178**	80.6246
28	11.6824	0.0000	100.4281	**132.7672**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.640	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.822	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00032	
(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 =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

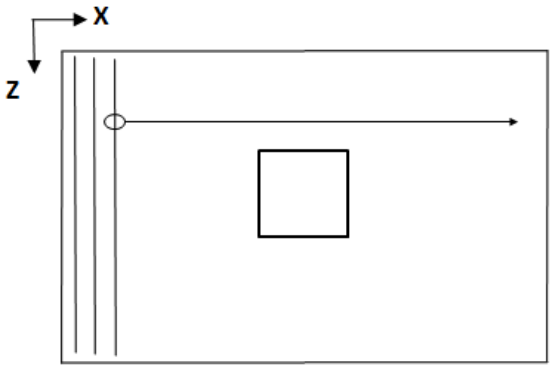
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	16.924	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	18.804	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00056	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00041	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

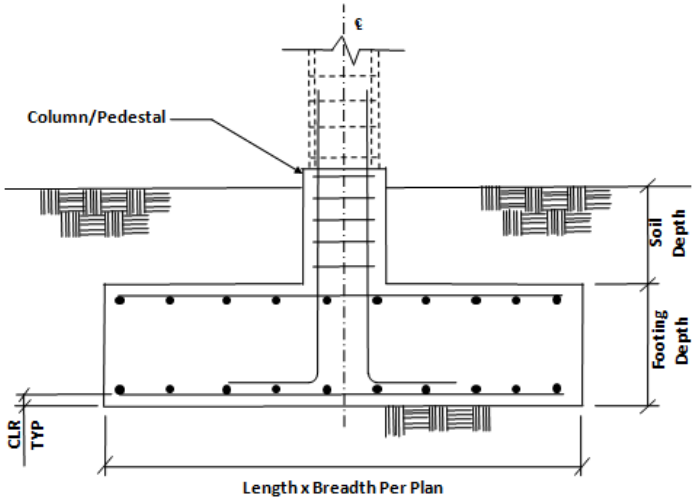
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

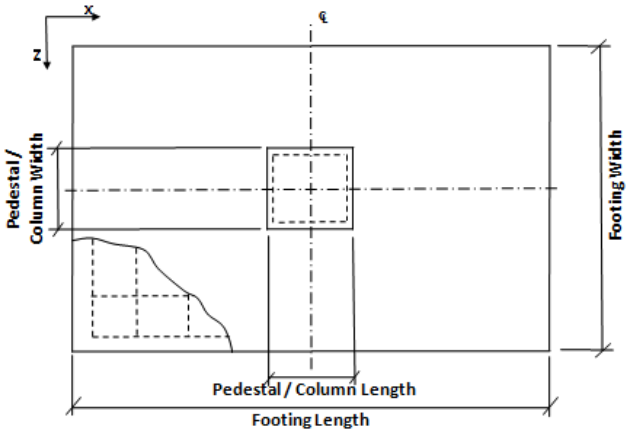
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 61



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	56.551	-0.384	-5.181	-9.299	-0.029
23	52.118	3.566	-3.854	-6.562	-6.477
24	53.630	-3.663	-4.004	-6.782	5.241
25	53.003	2.821	-5.539	-10.323	-5.258
26	54.515	-4.408	-5.689	-10.543	6.460
27	51.608	1.906	-1.927	-2.219	-3.800
28	52.059	-0.251	-1.972	-2.285	-0.302
29	54.574	-0.590	-7.571	-14.820	0.285
30	55.025	-2.748	-7.616	-14.886	3.783
31	24.576	4.976	-0.910	-1.150	-8.560
32	26.585	-4.627	-1.110	-1.443	7.007

33	25.750	3.988	-3.143	-6.135	-6.944
34	27.758	-5.615	-3.343	-6.427	8.622
35	23.898	2.768	1.652	4.625	-4.999
36	24.496	-0.091	1.592	4.538	-0.364
37	28.436	-3.407	-5.905	-12.202	5.062
38	27.838	-0.548	-5.846	-12.115	0.427

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	73.037	-0.401	-6.871	-12.352	-0.067
40	62.988	7.101	-4.135	-6.755	-12.334
41	65.866	-6.656	-4.422	-7.174	9.966
42	64.682	5.676	-7.358	-13.949	-10.002
43	67.559	-8.081	-7.644	-14.368	12.298
44	62.020	3.949	-0.476	1.491	-7.250
45	62.883	-0.178	-0.562	1.366	-0.560
46	67.664	-0.802	-11.217	-22.489	0.523
47	68.528	-4.929	-11.303	-22.614	7.213
48	36.965	7.112	-1.436	-1.877	-12.269
49	39.843	-6.645	-1.722	-2.295	10.031
50	38.659	5.687	-4.658	-9.071	-9.937
51	41.536	-8.071	-4.944	-9.489	12.363
52	35.997	3.960	2.224	6.370	-7.185
53	36.860	-0.167	2.138	6.245	-0.495
54	41.642	-0.791	-8.518	-17.610	0.589
55	42.505	-4.918	-8.604	-17.736	7.279

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.512 m^2$

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) = 1.200 m Governing Load Case : # 25

Width (W_2) = 1.200 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)

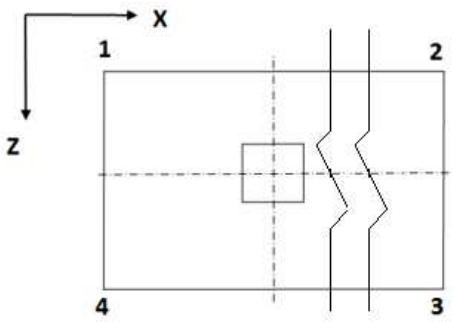
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**132.7229**	99.7728	-22.1164	10.8336	0.088
25	74.7905	**118.1618**	33.0075	-10.3638	0.021
35	-5.1008	36.3445	**72.4749**	31.0296	0.014
32	71.8634	11.9589	-0.7576	**59.1469**	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

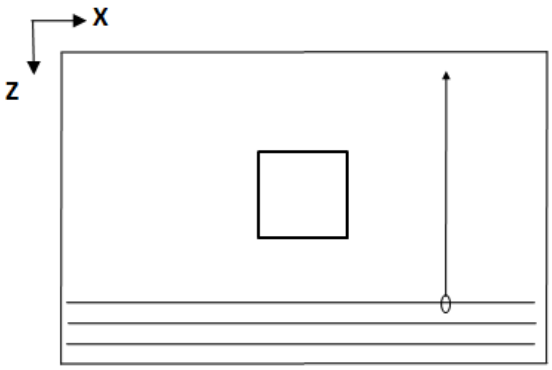
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**134.6611**	99.3407	0.0000	9.2487
25	74.6339	**118.3073**	32.8217	0.0000
35	0.0000	36.3239	**72.5469**	31.0058
32	71.8639	11.9587	0.0000	**59.1473**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	11.284	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.537	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

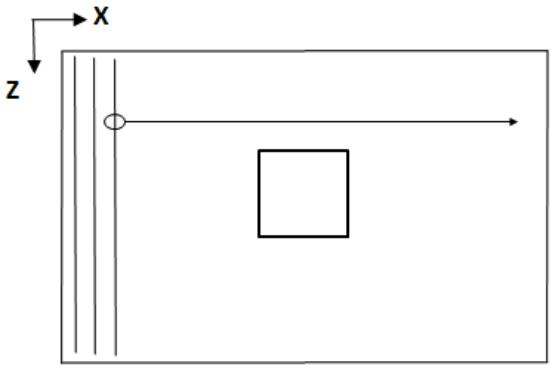
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	14.645	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	16.273	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00048	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00036	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

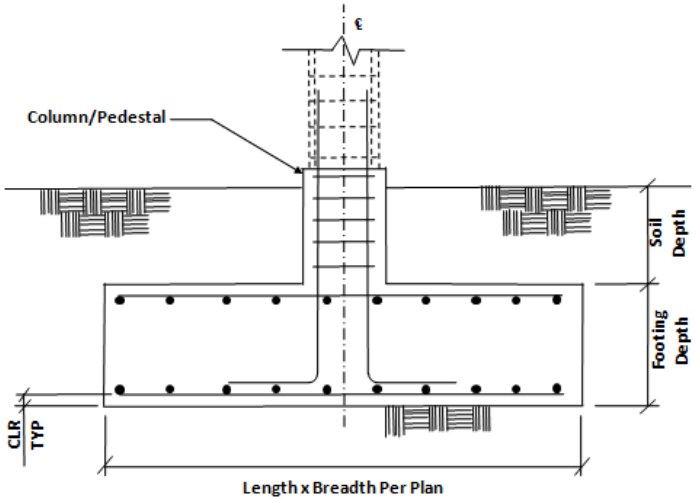
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

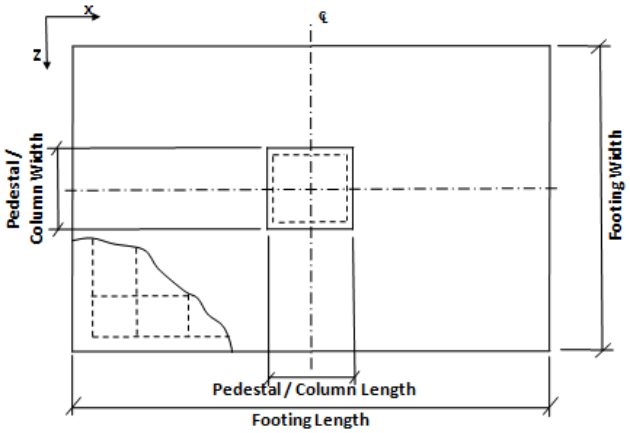
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 63



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	59.199	-0.767	6.419	10.349	0.389
23	56.584	1.892	6.575	11.036	-3.898
24	57.970	-4.194	6.780	11.416	5.895
25	55.725	2.610	5.026	7.613	-5.106
26	57.111	-3.476	5.231	7.993	4.687
27	58.080	-1.086	8.467	15.191	0.956
28	58.493	-2.903	8.529	15.305	3.879
29	55.201	1.318	3.277	3.724	-3.090
30	55.615	-0.498	3.339	3.837	-0.167
31	29.524	3.046	3.503	6.222	-5.457
32	31.366	-5.038	3.775	6.726	7.552

33	28.386	3.997	1.450	1.686	-7.057
34	30.227	-4.087	1.722	2.190	5.952
35	31.513	-0.914	6.019	11.747	0.998
36	32.062	-3.321	6.100	11.897	4.871
37	28.238	-0.127	-0.794	-3.335	-0.503
38	27.690	2.280	-0.875	-3.485	-4.376

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	74.801	-0.880	8.529	13.754	0.457
40	68.660	4.164	8.577	14.663	-7.692
41	71.298	-7.417	8.967	15.385	10.944
42	67.017	5.536	5.614	8.117	-10.002
43	69.655	-6.045	6.004	8.839	8.634
44	71.500	-1.491	12.170	22.554	1.525
45	72.292	-4.965	12.287	22.770	7.116
46	66.023	3.084	2.293	0.732	-6.174
47	66.815	-0.390	2.410	0.949	-0.583
48	44.316	4.323	5.205	9.221	-7.792
49	46.954	-7.258	5.595	9.944	10.844
50	42.673	5.696	2.242	2.675	-10.102
51	45.311	-5.885	2.632	3.397	8.535
52	47.156	-1.331	8.798	17.112	1.425
53	47.948	-4.806	8.915	17.328	7.016
54	41.679	3.244	-1.078	-4.710	-6.274
55	42.471	-0.230	-0.961	-4.493	-0.683

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.530m^2$

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) = 1.200 m Governing Load Case : # 23

Width (W_2) = 1.200 m Governing Load Case : # 23

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)

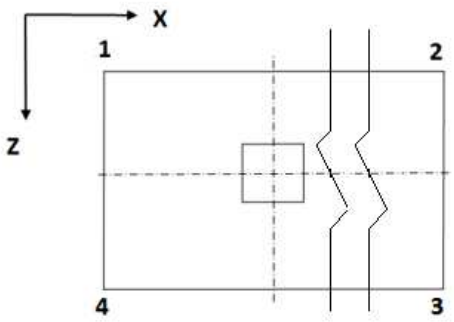
Area (A_2) = 1.440 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 12.096 kN

Soil Weight On Top Of Footing = 12.516 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	**54.0176**	2.7501	22.1473	73.4148	0.000
38	31.5192	**67.4517**	41.1215	5.1891	0.000
23	-5.7607	25.9091	**118.5317**	86.8620	0.007
28	11.2020	-22.7916	104.2214	**138.2150**	0.085

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

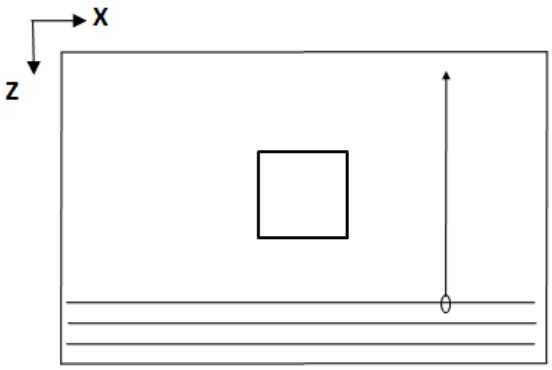
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
34	**54.0176**	2.7501	22.1473	73.4148
38	31.5192	**67.4517**	41.1215	5.1891
23	0.0000	25.8918	**118.5822**	86.8546
28	10.8962	0.0000	104.7781	**140.9559**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.425	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	11.109	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.344	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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) =	785.418	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00242	

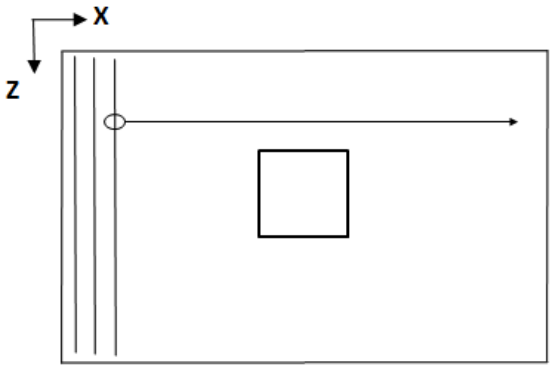
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.425	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	17.767	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	19.741	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00058	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00043	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	756.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 115.556mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.350	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	10	

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

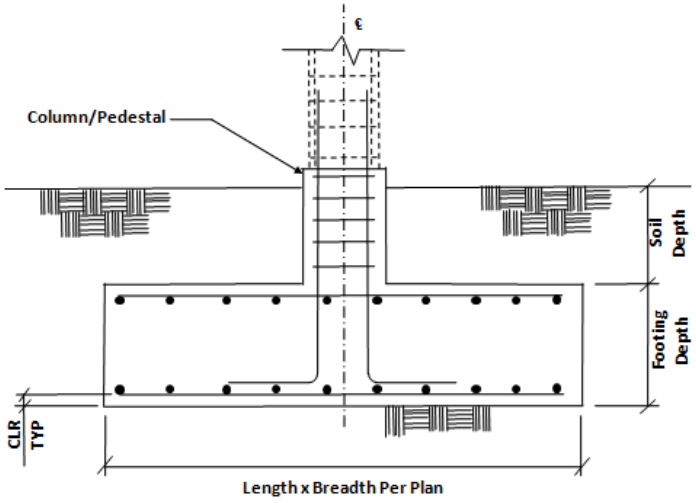
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	785.418	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00252	

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

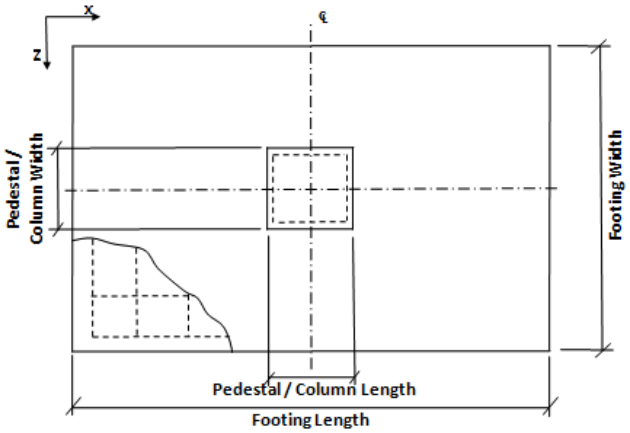
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 65



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	67.996	-0.909	-0.114	-0.808	1.523
23	65.991	1.125	0.693	0.502	-3.646
24	67.849	-2.863	0.495	0.158	6.492
25	65.889	1.194	-0.696	-1.652	-3.708
26	67.746	-2.794	-0.894	-1.995	6.430
27	66.763	-0.354	2.256	2.912	-0.017
28	67.317	-1.545	2.197	2.809	3.009
29	66.420	-0.124	-2.397	-4.303	-0.225
30	66.974	-1.314	-2.457	-4.405	2.801
31	36.926	2.238	1.016	1.316	-6.093
32	39.393	-3.060	0.753	0.860	7.373

33	36.790	2.329	-0.824	-1.538	-6.175
34	39.257	-2.969	-1.088	-1.994	7.291
35	37.952	0.270	3.094	4.521	-1.268
36	38.687	-1.307	3.016	4.385	2.741
37	38.231	-1.001	-3.166	-5.198	2.466
38	37.496	0.576	-3.087	-5.063	-1.544

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	83.400	-1.211	-0.159	-1.066	2.038
40	79.024	2.698	1.391	1.465	-7.863
41	82.559	-4.892	1.014	0.812	11.428
42	78.828	2.829	-1.266	-2.653	-7.982
43	82.363	-4.760	-1.643	-3.306	11.309
44	80.490	-0.112	4.358	6.042	-0.973
45	81.550	-2.389	4.245	5.846	4.814
46	79.837	0.326	-4.497	-7.687	-1.368
47	80.897	-1.951	-4.610	-7.883	4.419
48	55.468	3.181	1.464	1.878	-8.688
49	59.002	-4.409	1.086	1.225	10.603
50	55.272	3.312	-1.193	-2.241	-8.806
51	58.806	-4.277	-1.570	-2.894	10.484
52	56.934	0.371	4.431	6.454	-1.798
53	57.994	-1.906	4.318	6.259	3.989
54	56.281	0.809	-4.425	-7.275	-2.193
55	57.341	-1.468	-4.538	-7.471	3.594

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.592 m^2$

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 : # 22

Width (W_2) = 1.000 m Governing Load Case : # 22

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)

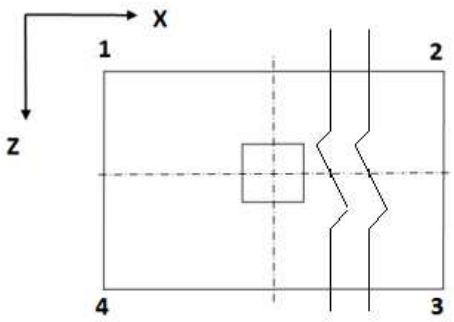
Area (A_2) = 1.000 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 8.400 kN

Soil Weight On Top Of Footing = 8.336 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	**142.7769**	53.8852	26.1866	115.0783	0.000
25	69.2446	**118.7514**	96.0043	46.4975	0.000
23	54.0244	102.4984	**111.4293**	62.9554	0.000
24	127.5567	37.6322	41.6117	**131.5361**	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

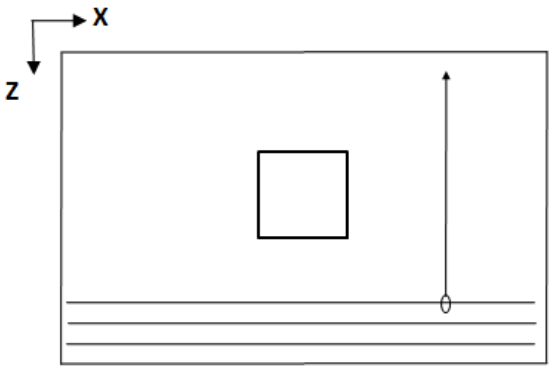
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
26	**142.7769**	53.8852	26.1866	115.0783
25	69.2446	**118.7514**	96.0043	46.4975
23	54.0244	102.4984	**111.4293**	62.9554
24	127.5567	37.6322	41.6117	**131.5361**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.325	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	8.505	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	9.450	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00031	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00024	
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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.250	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	

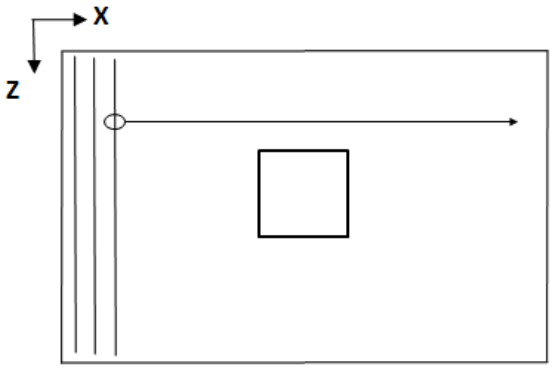
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.325	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	7.513	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	8.348	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 =		0.00022	
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 =	$0.5 \times (L - D_{col}) - C_{cover}$ =	0.250	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}

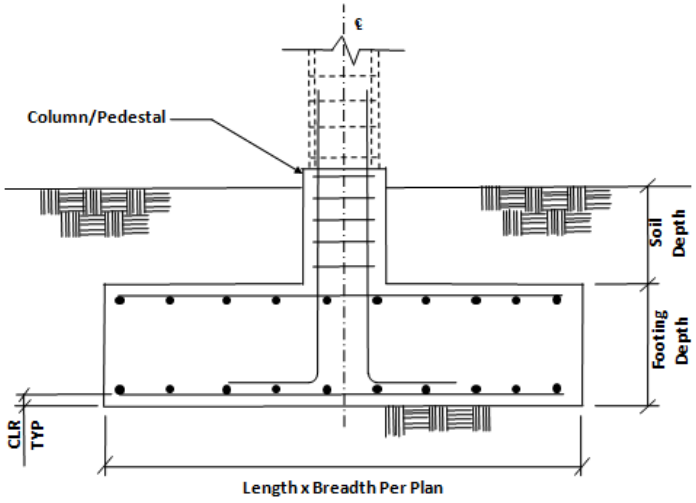
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	678.579	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.257	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00264	

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

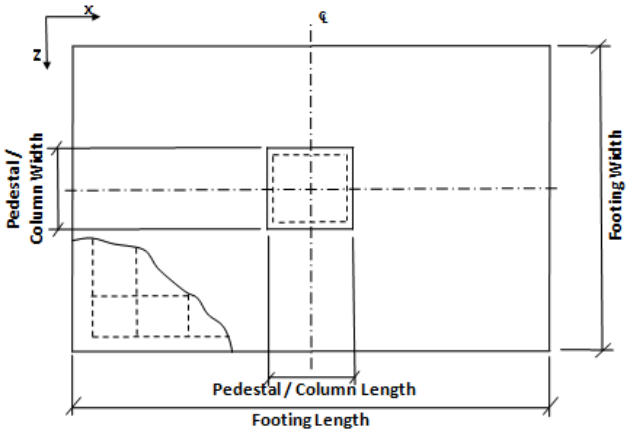
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 134



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	70.981	-1.844	-4.084	4.259	-1.274
23	65.910	2.455	-3.129	5.838	-7.813
24	69.067	-5.325	-3.145	5.843	4.084
25	68.225	1.642	-4.974	2.783	-6.602
26	71.383	-6.138	-4.990	2.789	5.295
27	64.296	0.682	-0.968	9.428	-5.064
28	65.239	-1.641	-0.972	9.430	-1.512
29	72.054	-2.042	-7.147	-0.803	-1.006
30	72.997	-4.364	-7.151	-0.802	2.546
31	33.354	4.605	-1.159	4.705	-9.432
32	37.549	-5.729	-1.179	4.713	6.372

33	36.422	3.528	-3.603	0.658	-7.827
34	40.617	-6.806	-3.623	0.666	7.977
35	31.208	2.247	1.716	9.480	-5.776
36	32.457	-0.830	1.710	9.482	-1.070
37	42.762	-4.448	-6.498	-4.109	4.320
38	41.513	-1.371	-6.492	-4.112	-0.385

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	88.913	-2.216	-4.941	5.025	-1.554
40	78.091	5.969	-3.103	8.070	-13.996
41	84.100	-8.835	-3.132	8.081	8.645
42	82.519	4.414	-6.630	2.228	-11.679
43	88.529	-10.390	-6.660	2.239	10.962
44	75.027	2.602	1.003	14.888	-8.774
45	76.830	-1.840	0.994	14.892	-1.982
46	89.790	-2.581	-10.756	-4.583	-1.052
47	91.592	-7.023	-10.765	-4.580	5.740
48	50.259	6.529	-1.808	6.943	-13.570
49	56.268	-8.276	-1.837	6.954	9.070
50	54.688	4.974	-5.335	1.102	-11.254
51	60.697	-9.831	-5.365	1.113	11.387
52	47.195	3.161	2.298	13.762	-8.349
53	48.998	-1.280	2.289	13.765	-1.557
54	61.958	-2.022	-9.462	-5.709	-0.626
55	63.761	-6.463	-9.470	-5.706	6.166

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.627m^2$

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) = 1.100 m Governing Load Case : # 23

Width (W_2) = 1.100 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)

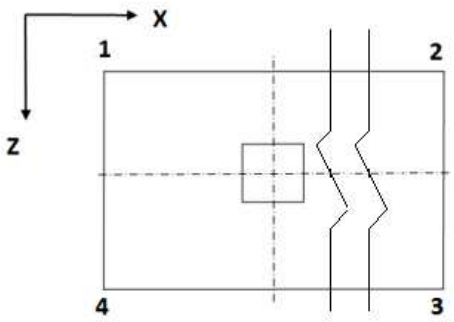
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**110.5255**	73.8008	44.0054	80.7300	0.000
25	36.2702	**100.9756**	110.3743	45.6690	0.000
27	5.1949	53.0017	**134.9552**	87.1483	0.000
24	79.4502	25.8270	68.5862	**122.2094**	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

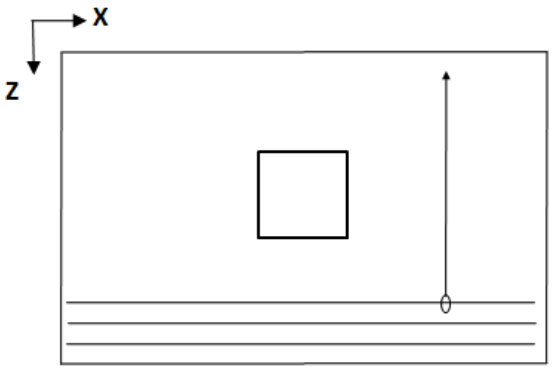
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**110.5255**	73.8008	44.0054	80.7300
25	36.2702	**100.9756**	110.3743	45.6690
27	5.1949	53.0017	**134.9552**	87.1483
24	79.4502	25.8270	68.5862	**122.2094**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	10.901	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.112	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

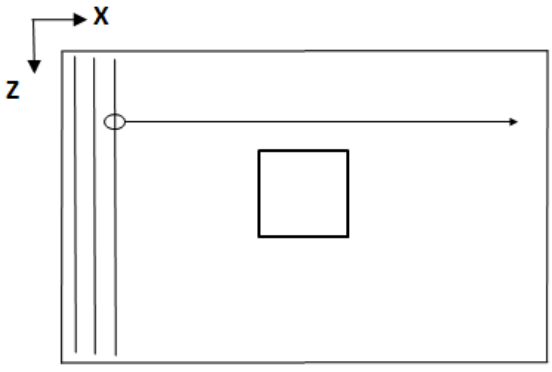
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.629	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.810	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00038	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

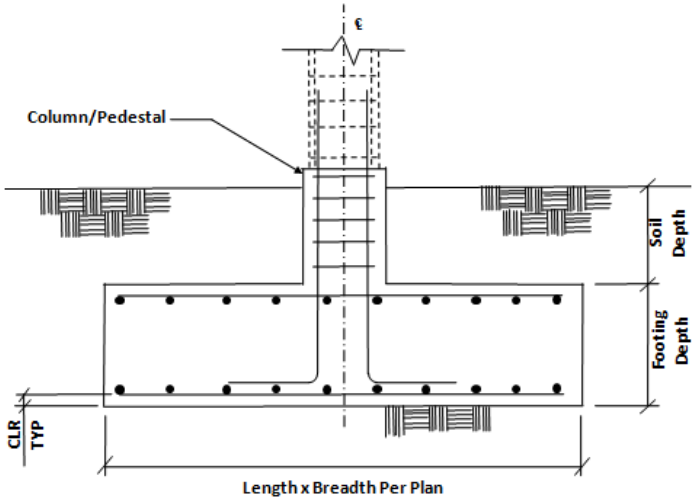
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

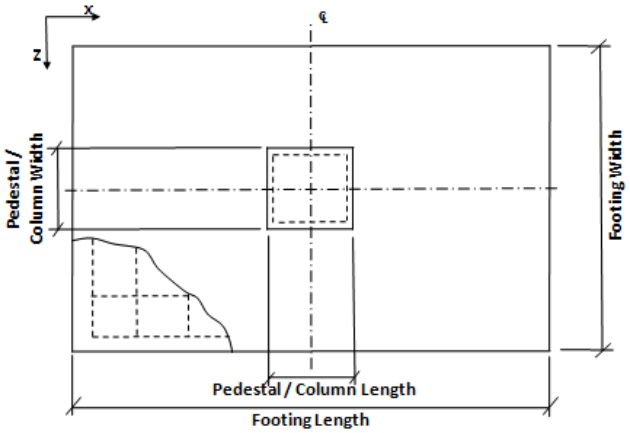
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 144



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	78.805	-0.312	0.021	-0.954	0.571
23	78.455	1.832	1.133	0.840	-4.779
24	75.669	-2.444	1.116	0.846	5.827
25	77.962	1.871	-1.069	-2.605	-4.778
26	75.176	-2.405	-1.086	-2.600	5.828
27	78.057	0.287	3.714	4.891	-1.060
28	77.226	-0.989	3.709	4.892	2.105
29	76.406	0.416	-3.663	-6.652	-1.057
30	75.574	-0.860	-3.668	-6.650	2.109
31	44.686	2.688	1.488	1.884	-6.814
32	40.984	-2.992	1.466	1.891	7.274

33	44.033	2.739	-1.430	-2.682	-6.813
34	40.331	-2.940	-1.452	-2.674	7.275
35	44.156	0.633	4.921	7.270	-1.869
36	43.054	-1.058	4.914	7.272	2.326
37	40.861	-0.886	-4.885	-8.061	2.330
38	41.963	0.805	-4.878	-8.063	-1.865

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	97.749	-0.415	0.021	-1.262	0.760
40	96.097	3.677	2.149	2.204	-9.444
41	90.795	-4.459	2.117	2.215	10.738
42	95.154	3.751	-2.063	-4.386	-9.442
43	89.852	-4.385	-2.095	-4.375	10.740
44	95.341	0.743	7.051	9.896	-2.383
45	93.751	-1.698	7.041	9.899	3.672
46	92.199	0.990	-6.987	-12.070	-2.376
47	90.608	-1.451	-6.997	-12.067	3.678
48	66.885	3.842	2.149	2.697	-9.746
49	61.583	-4.294	2.117	2.708	10.436
50	65.943	3.916	-2.063	-3.893	-9.744
51	60.640	-4.220	-2.095	-3.882	10.438
52	66.129	0.908	7.051	10.389	-2.685
53	64.539	-1.533	7.041	10.392	3.370
54	62.987	1.154	-6.987	-11.577	-2.678
55	61.396	-1.286	-6.997	-11.574	3.376

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.667 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

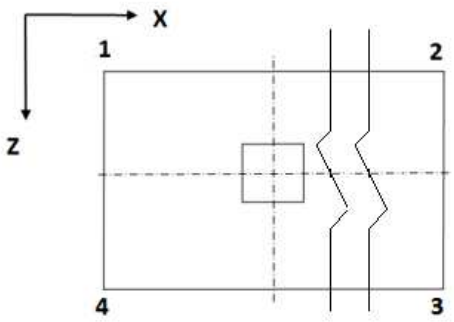
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**126.0254**	104.2987	32.7658	54.4926	0.000
29	110.4274	**121.2708**	49.7386	38.8952	0.000
27	48.3081	58.7733	**114.5875**	104.1223	0.000
28	63.9061	41.8012	97.6148	**119.7196**	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

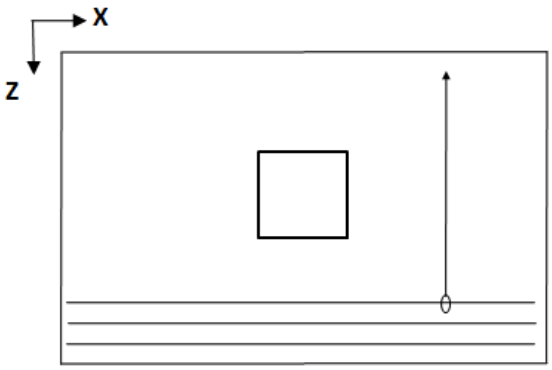
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**126.0254**	104.2987	32.7658	54.4926
29	110.4274	**121.2708**	49.7386	38.8952
27	48.3081	58.7733	**114.5875**	104.1223
28	63.9061	41.8012	97.6148	**119.7196**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.426	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.585	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00035	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

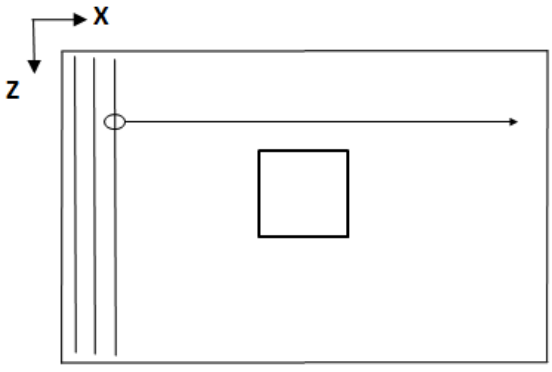
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	11.113	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.348	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00040	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00030	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

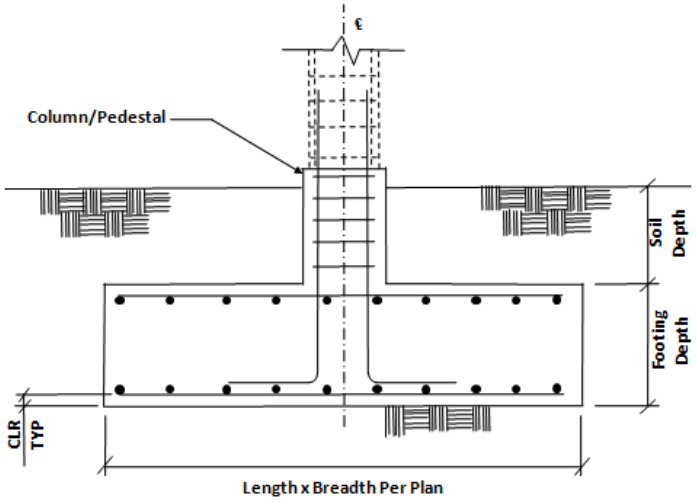
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

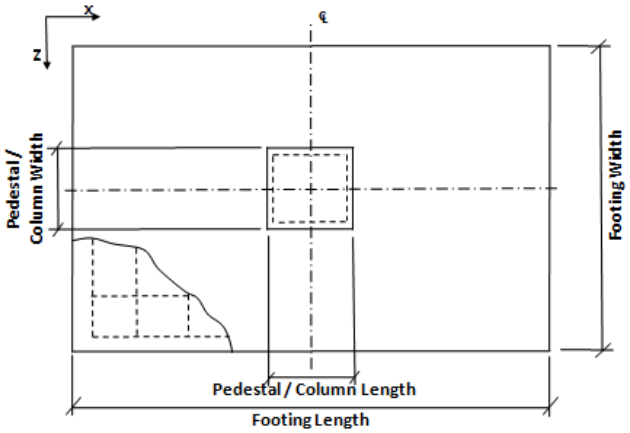
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 145



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) = 1.000m

Initial Width (W_o) = 1.000m

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	68.100	0.937	-0.110	-0.805	-1.566
23	67.997	2.839	0.800	0.630	-6.511
24	66.165	-1.145	0.996	0.970	3.620
25	67.763	2.864	-1.189	-2.460	-6.482
26	65.931	-1.120	-0.993	-2.119	3.649
27	67.630	1.412	3.206	4.379	-2.992
28	67.083	0.223	3.265	4.481	0.032
29	66.845	1.496	-3.458	-5.971	-2.894
30	66.298	0.307	-3.399	-5.869	0.130
31	39.505	3.006	1.153	1.483	-7.364
32	37.072	-2.287	1.415	1.935	6.094

33	39.194	3.039	-1.482	-2.611	-7.325
34	36.762	-2.253	-1.221	-2.159	6.133
35	39.017	1.109	4.353	6.469	-2.684
36	38.293	-0.467	4.431	6.604	1.323
37	37.250	-0.356	-4.421	-7.145	1.454
38	37.974	1.220	-4.499	-7.279	-2.553

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	83.538	1.248	-0.153	-1.063	-2.096
40	82.778	4.829	1.594	1.713	-11.439
41	79.293	-2.753	1.968	2.360	7.841
42	82.330	4.877	-2.210	-4.196	-11.383
43	78.845	-2.705	-1.836	-3.548	7.897
44	82.081	2.120	6.163	8.833	-4.757
45	81.035	-0.155	6.276	9.027	1.027
46	80.587	2.279	-6.518	-10.863	-4.569
47	79.541	0.005	-6.406	-10.669	1.214
48	59.167	4.332	1.664	2.124	-10.591
49	55.681	-3.250	2.038	2.772	8.689
50	58.718	4.380	-2.140	-3.785	-10.535
51	55.233	-3.203	-1.766	-3.137	8.745
52	58.470	1.622	6.234	9.244	-3.908
53	57.424	-0.653	6.346	9.438	1.876
54	56.976	1.782	-6.448	-10.452	-3.721
55	55.930	-0.493	-6.335	-10.257	2.063

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.592 m^2$

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) = 1.100 m Governing Load Case : # 25

Width (W_2) = 1.100 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)

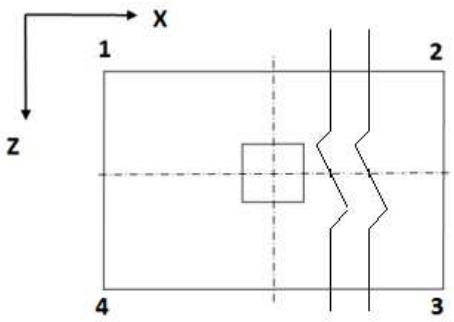
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**103.6541**	103.4453	39.8048	40.0135	0.000
29	89.1468	**119.9576**	55.2157	24.4049	0.000
27	32.3132	63.7455	**113.3469**	81.9147	0.000
28	46.8206	47.2332	97.9359	**97.5233**	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

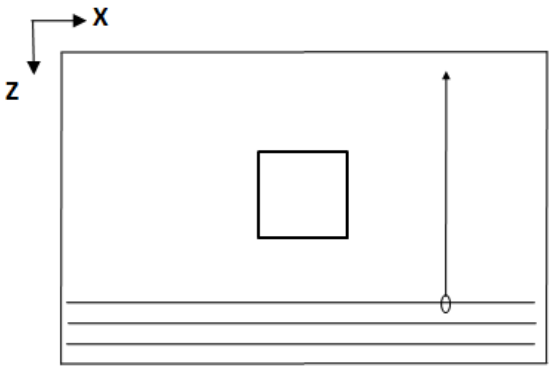
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**103.6541**	103.4453	39.8048	40.0135
29	89.1468	**119.9576**	55.2157	24.4049
27	32.3132	63.7455	**113.3469**	81.9147
28	46.8206	47.2332	97.9359	**97.5233**

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}=		0.270	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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\big\vert_{z=D_z}$ =	10.144	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.271	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00034	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00026	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

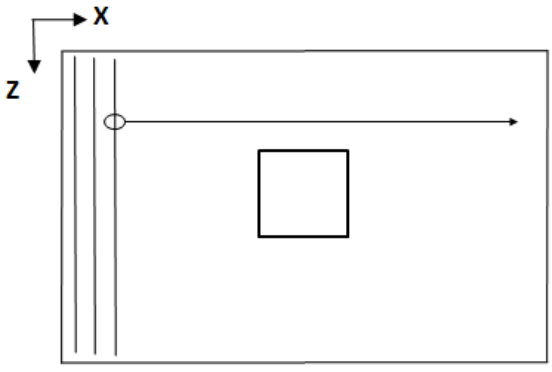
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	10.002	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	11.113	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00027	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot -C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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

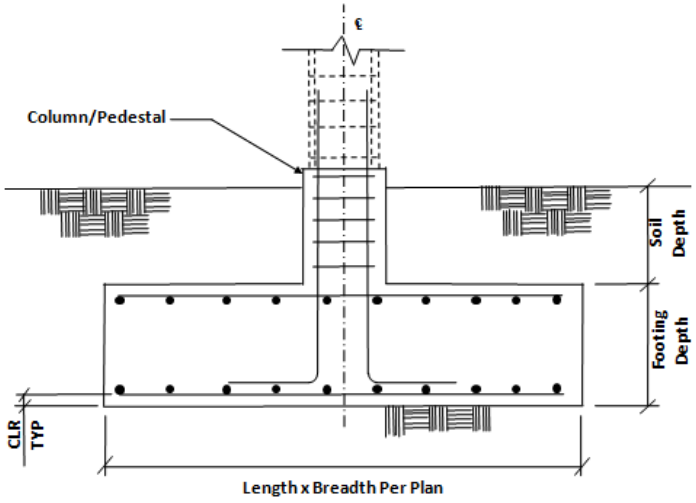
Total reinforcement area, A_{s_total} =	N_{bar} X (Area of one bar) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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

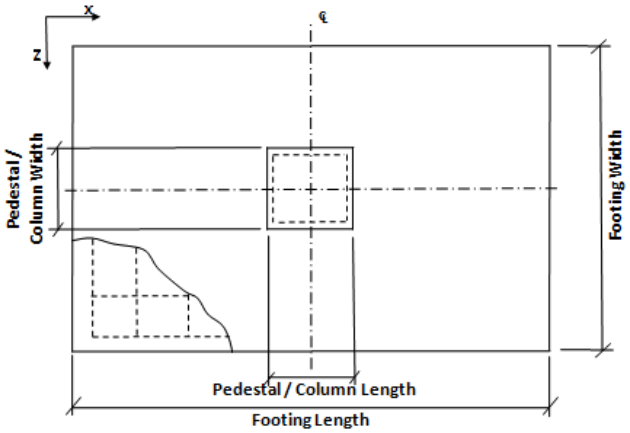
C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 50.000mm

Check to see if width is sufficient to accomodate bars

Isolated Footing 146



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	350.000mm
Footing Length - X (Fl) :	1000.000mm
Footing Width - Z (Fw) :	1000.000mm
Eccentricity along X (Oxd) :	0.000mm
Eccentricity along Z (Ozd) :	0.000mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (D_{col}) :	0.350m
Column Width - Z (B_{col}) :	0.350m

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) =	1.000m
Initial Width (W_o) =	1.000m

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	87.315	-0.017	-0.079	-1.248	0.027
23	84.823	2.060	1.109	0.725	-5.207
24	84.805	-2.120	1.110	0.727	5.236
25	84.513	2.088	-1.247	-3.025	-5.187
26	84.495	-2.091	-1.246	-3.023	5.256
27	85.181	0.560	3.878	5.133	-1.568
28	85.175	-0.687	3.879	5.133	1.550
29	84.142	0.656	-4.016	-7.431	-1.501
30	84.137	-0.592	-4.015	-7.430	1.616
31	46.231	2.750	1.538	1.973	-6.939
32	46.207	-2.802	1.539	1.975	6.933

33	45.821	2.788	-1.584	-2.996	-6.913
34	45.797	-2.764	-1.583	-2.994	6.959
35	46.707	0.756	5.220	7.834	-2.099
36	46.700	-0.897	5.221	7.834	2.031
37	45.321	-0.770	-5.265	-8.854	2.119
38	45.328	0.883	-5.266	-8.855	-2.011

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
39	109.028	-0.023	-0.111	-1.657	0.036
40	102.967	3.930	2.166	2.166	-9.925
41	102.932	-4.023	2.168	2.170	9.947
42	102.374	3.985	-2.341	-5.006	-9.887
43	102.339	-3.969	-2.339	-5.003	9.985
44	103.646	1.083	7.424	10.535	-3.014
45	103.636	-1.303	7.425	10.536	2.948
46	101.670	1.265	-7.598	-13.373	-2.888
47	101.660	-1.121	-7.597	-13.372	3.074
48	69.335	3.939	2.219	2.819	-9.940
49	69.300	-4.014	2.221	2.822	9.933
50	68.742	3.994	-2.288	-4.354	-9.902
51	68.707	-3.960	-2.286	-4.350	9.971
52	70.014	1.092	7.477	11.188	-3.028
53	70.004	-1.294	7.478	11.189	2.933
54	68.038	1.274	-7.545	-12.720	-2.902
55	68.028	-1.112	-7.545	-12.719	3.059

Reduction of force due to buoyancy = 0.000kN

Effect due to adhesion = 0.000kN

Area from initial length and width, $A_o = L_o \times W_o = 1.000 m^2$

Min. area required from bearing pressure, $A_{min} = P / q_{max} = 0.727 m^2$

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) = 1.100 m Governing Load Case : # 23

Width (W_2) = 1.100 m Governing Load Case : # 23

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)

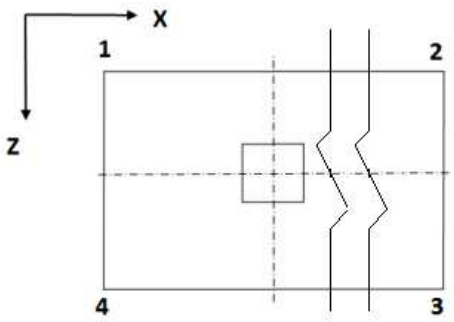
Area (A_2) = 1.210 m^2

Final Soil Height = 0.500 m

Footing Self Weight = 10.164 kN

Soil Weight On Top Of Footing = 10.331 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	**134.5214**	118.0845	38.4230	54.8599	0.000
29	118.5079	**134.1129**	54.4454	38.8403	0.000
27	50.1278	66.0286	**124.5421**	108.6413	0.000
28	66.1414	50.0001	108.5197	**124.6609**	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

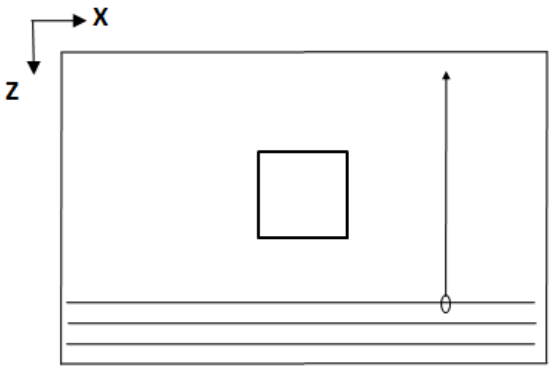
Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
30	**134.5214**	118.0845	38.4230	54.8599
29	118.5079	**134.1129**	54.4454	38.8403
27	50.1278	66.0286	**124.5421**	108.6413
28	66.1414	50.0001	108.5197	**124.6609**

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 =	$0.5 \times L - 0.5 \times D_{col} + O_{xd}$ =	0.375	m
Ultimate moment,	$M_u\|_{z=D_z}$ =	10.948	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	12.164	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00036	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00028	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 0.5 X (dia. of one bar) =	0.270	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00238	

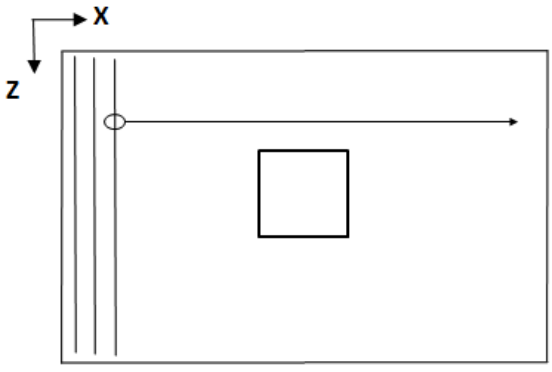
From ACI Cl.7.6.1, minimum req'd clear distance between bars

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}=		0.260	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 =	$0.5 \times L + 0.5 \times B_{col} + O_{zd}$ =	0.375	m
Ultimate moment,	$M_u\|_{x=D_x}$ =	12.127	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	13.474	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00043	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00032	
Since	$\rho \leq \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	693.002	mm2

Selected Bar Size = #10

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

Selected spacing (S) = 117.500mm

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 @ 115.000mm 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 =	$0.5 \times (L - D_{col}) \cdot - C_{cover}$ =	0.300	m
Try bar size # 10	Area of one bar =	78.542	mm2
Number of bars required, N_{bar} =	$\frac{A_s}{A_{bar}}$ =	9	

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) =	706.876	mm2
d_{eff} =	D - C_{cover} - 1.5 X (dia. of one bar) =	0.260	m
Reinforcement ratio, ρ =	$\frac{A_{s\_total}}{(d_{eff} \times W)}$ =	0.00247	

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