Isolated Footing Design(ACI 318-11)

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
173	1	1.000m	1.000m	0.300m

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
173	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
174	2	1.000m	1.000m	0.300m

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
174	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
175	3	1.000m	1.000m	0.300m

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
175	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
176	4	1.000m	1.000m	0.300m

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
176	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
177	5	1.000m	1.000m	0.300m

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

177	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
178	6	1.000m	1.000m	0.300m

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
178	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
179	7	1.030m	1.030m	0.300m

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
179	# 12 @ 22 cm c/c	# 12 @ 22 cm c/c	# 12 @ 22 cm c/c	# 12 @ 22 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
180	8	1.110m	1.110m	0.300m

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
180	# 16 @ 45 cm c/c	# 16 @ 45 cm c/c	# 16 @ 45 cm c/c	# 16 @ 45 cm c/c	N/A	N/A

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
181	9	1.000m	1.000m	0.300m

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
181	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

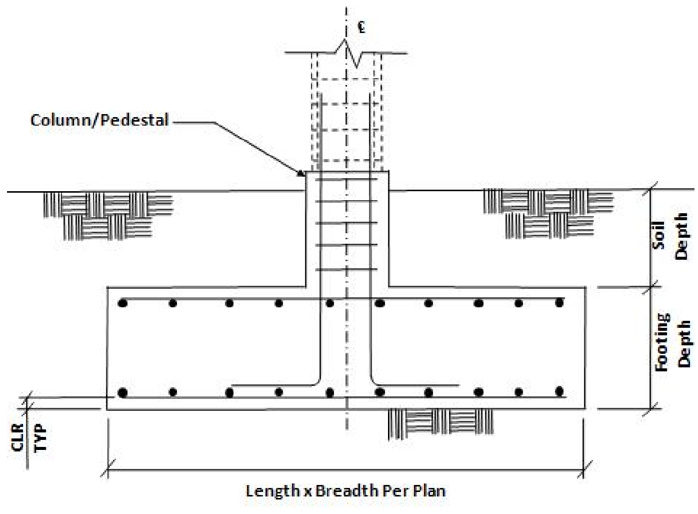
Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
202	10	1.000m	1.000m	0.300m

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
202	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

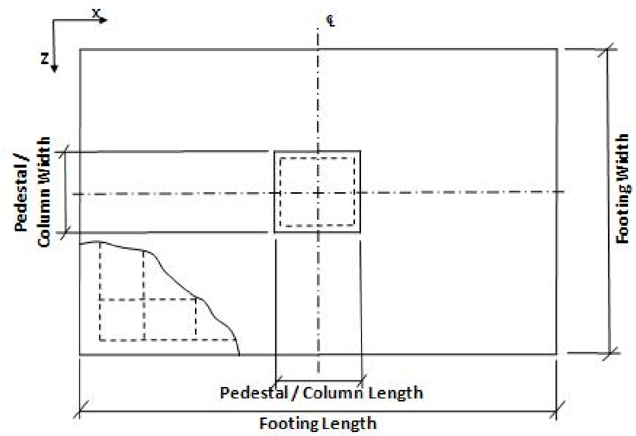
Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
212	11	1.000m	1.000m	0.300m

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
212	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	# 12 @ 21 cm c/c	N/A	N/A

Isolated Footing 173



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	300.000mm
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}) :	0.250m
Column Width - Z (B_{col}) :	0.250m

Pedestal

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

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	24.000kN/m3
Strength of Concrete :	21.000N/mm2
Yield Strength of Steel :	420.000N/mm2
Minimum Bar Size :	# 12
Maximum Bar Size :	# 20
Pedestal Minimum Bar Size :	8
Pedestal Maximum Bar Size :	9
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 :	1.000m
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
5	1.2 CM + 1.600 CV	1.00	1.00	1.00
6	1.2 CM + CV + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
7	1.2 CM + CV - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
8	1.2 CM + CV + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
9	1.2 CM + CV - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
10	1.2 CM + CV + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
11	1.2 CM + CV - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
12	1.2 CM + CV + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
13	1.2 CM + CV - (0.3 SX/R + SZ/R)	1.00	1.00	1.00
14	0.9 CM + (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
15	0.9 CM - (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
16	0.9 CM + (SX/R - 0,30 SZ/R)	1.00	1.00	1.00
17	0.9 CM - (SX/R + 0,30 SZ/R)	1.00	1.00	1.00
18	0.9 CM + (0.3 SX/R + SZ/R)	1.00	1.00	1.00
19	0.9 CM - (0.3 SX/R - SZ/R)	1.00	1.00	1.00
20	0.9 CM + (0.3 SX/R - SZ/R)	1.00	1.00	1.00
21	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	58.525	-1.499	3.565	1.165	0.445
23	59.319	1.852	4.666	2.014	-1.639
24	53.030	-5.158	3.601	1.334	2.720
25	58.171	2.104	3.704	0.979	-1.798
26	51.882	-4.906	2.639	0.299	2.560
27	58.136	-0.820	5.143	2.691	0.024
28	56.559	-3.001	5.089	2.772	1.382
29	54.642	-0.053	2.216	-0.459	-0.460
30	52.747	-2.165	1.895	-0.664	0.853
31	33.026	3.517	3.690	1.813	-2.482
32	24.681	-5.784	2.278	0.910	3.302

33	31.511	3.850	2.421	0.447	-2.692
34	23.166	-5.452	1.009	-0.455	3.092
35	31.875	-0.130	4.680	3.093	-0.210
36	29.375	-2.916	4.257	2.823	1.522
37	24.317	-1.805	0.019	-1.736	0.820
38	26.817	0.981	0.442	-1.466	-0.912

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
5	74.909	-1.753	4.137	1.412	0.509
6	74.944	4.591	6.269	3.017	-3.438
7	63.011	-8.710	4.249	1.726	4.832
8	72.770	5.068	4.447	1.056	-3.739
9	60.836	-8.233	2.427	-0.234	4.531
10	73.301	-0.615	7.681	4.845	-0.195
11	69.713	-4.614	7.074	4.457	2.291
12	66.068	0.972	1.622	-1.675	-1.198
13	62.480	-3.027	1.015	-2.063	1.288
14	49.198	4.961	5.445	2.643	-3.527
15	37.264	-8.340	3.425	1.353	4.743
16	47.023	5.438	3.623	0.683	-3.829
17	35.090	-7.863	1.604	-0.608	4.441
18	47.554	-0.245	6.857	4.472	-0.284
19	43.966	-4.245	6.250	4.084	2.202
20	40.321	1.342	0.798	-2.048	-1.288
21	36.733	-2.657	0.191	-2.436	1.199

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, $A_{min} = P / q_{max}$ = 0.552m^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 :	# 0
Width (W_2) =	1.000	m	Governing Load Case :	# 0
Depth (D_2) =	0.300	m	Governing Load Case :	# 10

Depth is governed by Ultimate Load Case

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

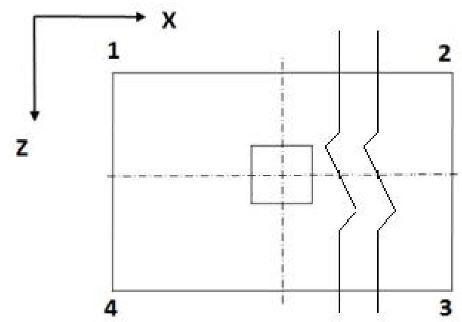
Area (A_2) = 1.000 m^2

Final Soil Height = 0.700 m

Footing Self Weight = 7.200 kN

Soil Weight On Top Of Footing = 12.468 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	**89.1977**	40.8125	53.9015	102.2867	0.000
25	50.7212	**79.8750**	104.9563	75.8025	0.000
23	45.3357	71.6703	**112.6387**	86.3041	0.000
28	64.1253	36.7408	88.3286	**115.7131**	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

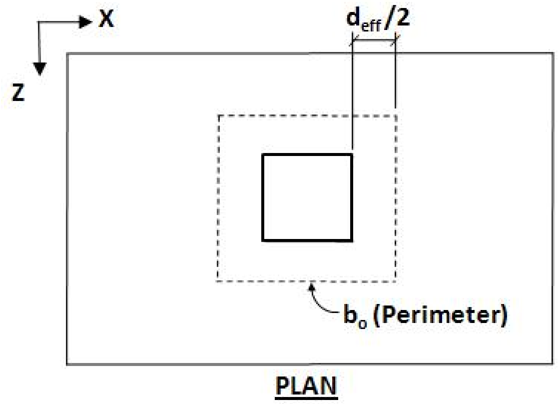
Load Case	Pressure at corner 1 (q_1) (kN/ m2)	Pressure at corner 2 (q_2) (kN/ m2)	Pressure at corner 3 (q_3) (kN/ m2)	Pressure at corner 4 (q_4) (kN/ m2)
26	**89.1977**	40.8125	53.9015	102.2867
25	50.7212	**79.8750**	104.9563	75.8025
23	45.3357	71.6703	**112.6387**	86.3041
28	64.1253	36.7408	88.3286	**115.7131**

Compression Development Length Check

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

Shear Calculation

Punching Shear Check



Total Footing Depth, D =	0.300m	
Calculated Effective Depth, d_{eff} =	D - C_{cover} - 0.5 * d_b =	0.219m
For rectangular column, β_c =	B_{col} / D_{col} =	1.000

Effective depth, d_{eff}, increased until $0.75XV_c \geq$ Punching Shear Force

Punching Shear Force, Vu = 73.801kN, Load Case # 6

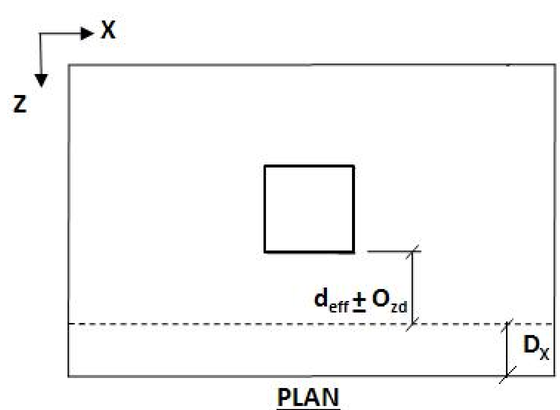
From ACI Cl.11.11.2, b_o for column=	$2 \times (B_{col} + D_{col} + 2 \times d_{eff})$ =	1.876m
Equation 11-31, V_{c1} =	$\left(2 + \frac{4}{\beta_c}\right) \times b_o \times d_{eff} \times \sqrt{1000 \times F_c'}$ =	937.988kN
Equation 11-32, V_{c2} =	$\left(2 + 40 \times \frac{d_{eff}}{b_o}\right) \times b_o \times d_{eff} \times \sqrt{1000 \times F_c'}$ =	1042.654kN
Equation 11-33, V_{c3} =	$4 \times b_o \times d_{eff} \times \sqrt{1000 \times F_c'}$ =	625.326kN
Punching shear strength, V_c =	0.75 X minimum of (V_{c1}, V_{c2}, V_{c3}) =	468.994kN

$0.75 X V_c > V_u$ hence, OK

One-Way Shear Check

Along X Direction

(Shear Plane Parallel to Global X Axis)



From ACI Cl.11.2.1.1, V_c = $2 \times L \times d_{eff} \times \sqrt{1000 \times F_c'}$ = 166.665kN

Distance along X to design for shear, D_x = $0.5 \times (W - D_{col}) - d_{eff} + O_{zd}$ = 0.156m

Check that 0.75 X V_c > V_{ux} where V_{ux} is the shear force for the critical load cases at a distance d_{eff} from the face of the column caused by bending about the X axis.

From above calculations, 0.75 X V_c = 124.998 kN

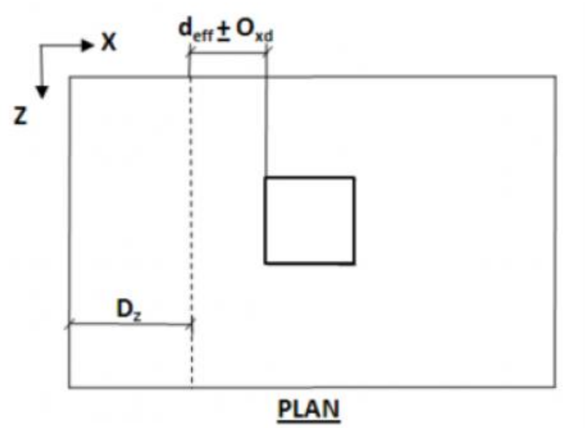
Critical load case for V_{ux} is # 10 $V_{ux} = V_{ux}|_{x=D_x}$ = 20.151 kN

0.75 X V_c > V_{ux} hence, OK

One-Way Shear Check

Along Z Direction

(Shear Plane Parallel to Global Z Axis)



From ACI Cl.11.2.1.1, V_c =

$2 \times W \times d_{eff} \times \sqrt{1000 \times F_c'}$ = 166.665 kN

Distance along X to design for shear, D_z = $0.5 \times (L - B_{col}) - d_{eff} + O_{xd}$ = 0.156 m

Check that **0.75 X V_c > V_{uz}** where V_{uz} is the shear force for the critical load cases at a distance d_{eff} from the face of the column caused by bending about the Z axis.

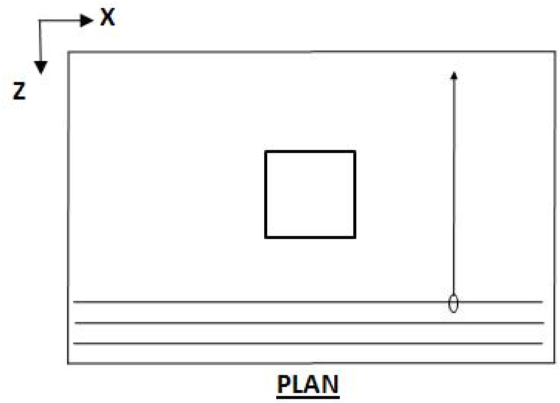
From above calculations, 0.75 X V_c = 124.998 kN

Critical load case for V_{uz} is # 7 $V_{uz} = V_{uz}|_{z=D_z}$ = 18.780 kN

0.75 X V_c > V_{uz} hence, OK

Design for Flexure about Z Axis

(For Reinforcement Parallel to X Axis)



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 # 6

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}=		0.219	m
Factor β_1 from ACI Cl.10.2.7.3 =		0.850	
From ACI Cl. 10.3.2, ρ_{bal} =	$0.85 \times \beta_1 \times F_c{}' \times \frac{87}{\left[f_y \times (87 + F_y)\right]}$ =	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,	$M_u\big\|_{z=D_z}$ =	8.178	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	9.086	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00045	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00033	
Since	$\rho \le \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	540.001	mm2

Selected bar Size = #12

Minimum spacing allowed (S_{min}) = = 5.000cm

Selected spacing (S) = 20.950cm

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 = 18.777cm

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

Based on spacing reinforcement increment; provided reinforcement is

12 @ 20.500cm o.c.

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

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot -C_{cover}$ = 0.300 m

Try bar size # 12 Area of one bar = 113.097 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 5

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) = 565.483 mm2

d_{eff} = D - C_{cover} - 0.5 X (dia. of one bar) = 0.219 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00258

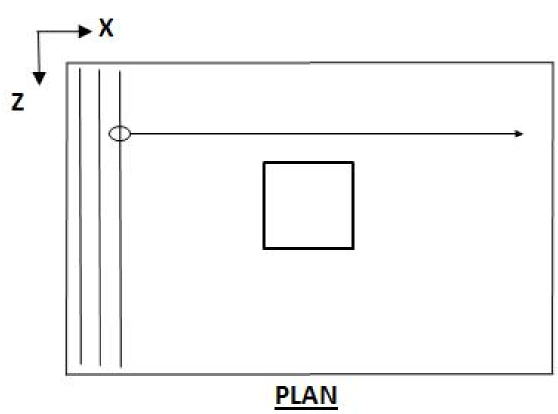
From ACI Cl.7.6.1, minimum req'd clear distance between bars

C_d = max (Diameter of one bar, 1.0" (25.4mm), Min. User Spacing) = 5.000cm

Check to see if width is sufficient to accomodate bars

Design for Flexure about X axis

(For Reinforcement Parallel to Z Axis)



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 # 10

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}=		0.207	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,	$M_u\|_{x=D_x}$ =	8.802	kNm
Nominal moment capacity, M_n =	$\frac{M_u}{\Phi}$ =	9.780	kNm
(Based on effective depth) Required ρ =	$\frac{1}{m} \times \left[1 - \sqrt{1 - 2 \times m \times \frac{M_n}{(F_y \times W \times d_{eff}^2)}}\right]$ =	0.00055	
(Based on gross depth) ρ x d_{eff} / Depth =		0.00038	
Since	$\rho \le \rho_{min}$	ρ_{min} Governs	
Area of Steel Required, A_s =	$\rho \times W \times d_{eff}$ =	540.001	mm2

Selected Bar Size = # 12

Minimum spacing allowed (S_{min}) = 5.000cm

Selected spacing (S) = 20.950cm

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 = 18.777cm

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

Based on spacing reinforcement increment; provided reinforcement is

12 @ 20.500cm o.c.

Required development length for bars = 0.305 m

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

Available development length for bars, D_L = $0.5 \times (L - D_{col}) \cdot -C_{cover}$ = 0.300 m

Try bar size # 12 Area of one bar = 113.097 mm2

Number of bars required, N_{bar} = $\frac{A_s}{A_{bar}}$ = 5

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) = 565.483 mm2

d_{eff} = D - C_{cover} - 1.5 X (dia. of one bar) = 0.207 m

Reinforcement ratio, ρ = $\frac{A_{s\_total}}{(d_{eff} \times W)}$ = 0.00273

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) = 5.000cm

Check to see if width is sufficient to accomodate bars

Isolated Footing 174