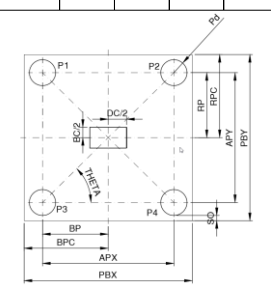




Step 3) Pilecap configuration and geometry (refer sketch-01)					
C/C distance between pile		D * Pile spacing	Apx	1500	mm
		D * Pile spacing	Apy	1500	mm
		(360/No of Piles)*PI()/180	Phi	1.571	Radian
		ATAN(Apy/Apx)	Theta	0.785	Radian
		Apx/2	Bp	750.00	mm
		Apy/2	Bp	750.00	mm
Pile-cap Base		Apx+ D* 2*Offset	PBx	2,400.00	mm
		Apy+ D* 2*Offset	Pby	2,400.00	mm
		Area of pilecap		5760000	sqmm
Position of Piles	Px	Py			
P1	750.00	750			
P2	750.00	750			
P3	750.00	750			
P4	750.00	750			
<b>Step 4) Check for maximum load on one pile</b>					
<b>Forces On Piles</b>					
Weight of pilecap + Overburden weight of soil		Soil Wt + Pilecap Wt		434.72	kN
Total Weight on Pile		Pcomb + Soil Wt + Pilecap Wt	Ptotal	2,075.48	kN
Load transfer to pile P1		Ptotal/No of Piles-(Mx/(2*Apx/1000))-(My/(2*Apy/1000))		541.22	kN
Load transfer to pile P2		Ptotal/No of Piles+(Mx/(2*Apx/1000))-(My/(2*Apy/1000))		548.15	kN
Load transfer to pile P3		Ptotal/No of Piles-(Mx/(2*Apx/1000))+(My/(2*Apy/1000))		489.59	kN
Load transfer to pile P4		Ptotal/No of Piles+(Mx/(2*Apx/1000))+(My/(2*Apy/1000))		496.52	kN
Ptotal					
Maximum load on one pile		Max(P1,P2,P3,P4)		548.15	kN
Allowable load on pile				1,650	kN
Check		Max load on one pile < All. load on one Pile			OK
<b>Step 5) Check for maximum load on pile group</b>					
Weight of pilecap + Overburden weight of soil		Soil Wt + Pilecap Wt		434.723	kN
Total Weight on Pile		Pcomb + Soil Wt + Pilecap Wt	Ptotal	2,051.70	kN
Maximum load on pile group			Pgroup	2,051.70	kN
Allowable load on pile group				6,600	kN
Check		Max load on pilegroup < All. load on Pilegroup			OK
<b>Step 6) Check for maximum shear on pile group</b>					
Maximum shear on pile group		Sqrt (Vx*2 + Vy*2)		39.60	kN
Shear Capacity of pile group		Shear capacity x No of piles	Ppile shear	800	kN
Check		Max shear on pilegroup < All. shear on Pilegroup			OK
<b>Step 7) Check for uplift on one pile</b>					
No uplift in any pile					
<b>Step 8) Design for Bending</b>					
Weight of pilecap + Overburden weight of soil		Soil Wt + Pilecap Wt		521.67	kN
Total Weight on Pile		Pcomb + Soil Wt + Pilecap Wt	Ptotal	4,549.78	kN
<b>Forces On Piles</b>					
Load transfer to pile P1		Ptotal/No of Piles-(Mux/(2*Apx/1000))-(Muy/(2*Apy/1000))		1,137.28	kN
Load transfer to pile P2		Ptotal/No of Piles+(Mux/(2*Apx/1000))-(Muy/(2*Apy/1000))		1,137.04	kN
Load transfer to pile P3		Ptotal/No of Piles-(Mux/(2*Apx/1000))+(Muy/(2*Apy/1000))		1,137.84	kN
Load transfer to pile P4		Ptotal/No of Piles+(Mux/(2*Apx/1000))+(Muy/(2*Apy/1000))		1,137.61	kN
Max Load on pile				1,137.84	kN
<b>Bottom reinforcement Along Column D</b>					
Effective depth of pilecap		Depth-Cover-20/2	Deff	1,065.00	mm
Effective width of pile cap		Pile dia+ 2*Offset	Beff	900.00	mm
offset from column face		(Apx/2-Dc/2)/1000	Dfcol	0.40	m
Bending moment due to pile load		P * Dfcol	Bmux	900.00	kN-m
% reinf. Required for Bending moment		(0.85*f'c/fy)*(1-SQRT(1-(2*(Bmux*10^6/(Beff*Deff^2))))/(0.9*0.85*f'c))	Pt min	0.24	%
% minimum reinforcement			Pt min	0.18	%
Area of reinf. Required		Pt *Deff *1000	Ast Req (BM)	2,560.06	sqmm/m
Area of reinforcement provided			Ast prv	2,604.74	sqmm/m
Check		Ast provided > Ast req			OK
<b>Top reinforcement Along Column D</b>					
Area of reinf. Required		Pt *Deff *1000	Ast req	2025.00	sqmm/m
Area of reinforcement provided			Ast provided	2046.58	sqmm/m
Check		Ast provided > Ast req			OK
<b>Bottom reinforcement Along Column B</b>					
Weight of pilecap + Overburden weight of soil		Soil Wt + Pilecap Wt		521.67	kN
Total Weight on Pile		Pcomb + Soil Wt + Pilecap Wt	Ptotal	4,549.78	kN
<b>Forces On Piles</b>					
Load transfer to pile P1		Ptotal/No of Piles-(Mux/(2*Apx/1000))-(Muy/(2*Apy/1000))		1,137.28	kN
Load transfer to pile P2		Ptotal/No of Piles+(Mux/(2*Apx/1000))-(Muy/(2*Apy/1000))		1,137.04	kN
Load transfer to pile P3		Ptotal/No of Piles-(Mux/(2*Apx/1000))+(Muy/(2*Apy/1000))		1,137.84	kN
Load transfer to pile P4		Ptotal/No of Piles+(Mux/(2*Apx/1000))+(Muy/(2*Apy/1000))		1,137.61	kN
Max Load on pile				1,137.84	kN
Effective depth of pilecap		Depth-Cover-20-20/2	Deff	1045.00	mm
Effective width of pile cap		Pile dia+ 2*Offset	Beff	900.00	mm
offset from column face		(Apy/2-Bc/2)/1000	Dfcol	0.40	m
Bending moment due to pile load		P * Dfcol	Bmux	900.00	kN-m
% reinf. Required for Bending moment		(0.85*f'c/fy)*(1-SQRT(1-(2*(Bmux*10^6/(Beff*Deff^2))))/(0.9*0.85*f'c))	Pt req	0.25	%
% minimum reinforcement			Pt min	0.18	%
Area of reinf. Required		Pt *Deff *1000	Ast Req (BM)	2612.25	sqmm/m
Area of reinforcement provided			Ast prv	2728.77	sqmm/m
Check		Ast provided > Ast req			OK
<b>Top reinforcement Along Column B</b>					
Area of reinf. Required		Pt *Deff *1000	Ast req	2025.00	sqmm/m
Area of reinforcement provided			Ast provided	2046.58	sqmm/m
Check		Ast provided > Ast req			OK
<b>Step 9) Design for Shear</b>					
Weight of pilecap + Overburden weight of soil		Soil Wt + Pilecap Wt		521.67	kN
Total Weight on Pile		Pcomb + Soil Wt + Pilecap Wt	Ptotal	4,549.78	kN
<b>Forces On Piles</b>					
Load transfer to pile P1		Ptotal/No of Piles-(Mux/(2*Apx/1000))-(Muy/(2*Apy/1000))		1,137.28	kN
Load transfer to pile P2		Ptotal/No of Piles+(Mux/(2*Apx/1000))-(Muy/(2*Apy/1000))		1,137.04	kN
Load transfer to pile P3		Ptotal/No of Piles-(Mux/(2*Apx/1000))+(Muy/(2*Apy/1000))		1,137.84	kN
Load transfer to pile P4		Ptotal/No of Piles+(Mux/(2*Apx/1000))+(Muy/(2*Apy/1000))		1,137.61	kN
Max Load on pile		Max (P1,P2,P3,P4)		1,137.84	kN
<b>Along Column D</b>					
Section location from column center					
Data For Pile					
Pile No	Load (kN)	Covered(mm)	% covered	Shear(kN)	
P1	2,250.00	2	432.5	72.08	628.13
P2	2,250.00	2	432.5	72.08	628.13
P3	2,250.00	2	432.5	72.08	628.13
P4	2,250.00	2	432.5	72.08	628.13
* Covered & % Covered calculation - Refer at the end of validation sheet					
<b>Design Shear Force</b>					
Effective depth of pilecap		Depth-Cover-20/2	Vu	1256.25	kN
Effective width of pile cap		Beff	Deff	1,065	mm
Reinforcement required		Ast req/(1000*Deff)	Beff	2,400.00	mm
			pt	0.0024	
design shear strength of concrete		Vu*d/Mu	phiVc	1,450.03	kN
Check		Vu < phiVc			OK
		(Vu - phiVc)/ phi	Vs	-	kN
Check		Vs > Vs perm	Vs perm	-	kN
<b>Shear Reinforcement Calculations</b>					
Area of shear reinforcement required		(Vs*1000/(Deff*fyt))*1000	Asv req	-	sqmm/m
Provided Shear reinforcement			Asv prv	-	sqmm/m
Shear capacity by Shear reinforcement		Asv prv* Deff* fyt	Vscap	-	kN
Check		phi * (Vc + Vs) > Vu			



SKETCH-01

$$11.2.2.1 \quad V_c = (0.16 \lambda / f'_c + 17 \rho_w / M_u) V_u d$$

$$= 0.292 \sqrt{f'_c} b_w d$$

$$11.4.7.9 \quad 0.66 \sqrt{f'_c} b_w d$$

<b>Along column B</b>									
Weight of pilecap + Overburden weight of soil			Soil Wt + Pilecap Wt		521.67		kN		
Total Weight on Pile			Pcomb + Soil Wt + Pilecap Wt		4,549.78		kN		
Forces On Piles									
Load transfer to pile P1			Ptotal/No of Piles-(Mux/(2*ApX/1000))-(Muy/(2*ApY/1000))		1,137.28		kN		
Load transfer to pile P2			Ptotal/No of Piles-(Mux/(2*ApX/1000))-(Muy/(2*ApY/1000))		1,137.04		kN		
Load transfer to pile P3			Ptotal/No of Piles-(Mux/(2*ApX/1000))-(Muy/(2*ApY/1000))		1,137.84		kN		
Load transfer to pile P4			Ptotal/No of Piles-(Mux/(2*ApX/1000))-(Muy/(2*ApY/1000))		1137.61092		kN		
Max Load on pile					1,137.84		kN		
Section location from column center					872.5		mm		
Pile No	Load (kN)	Covered(mm)	% covered	Shear(kN)					
P1	2,250.00	2	422.50	70.42	665.63				
P2	2,250.00	2	422.50	70.42	665.63				
P3	2,250.00	2	422.50	70.42	665.63				
P4	2,250.00	2	422.50	70.42	665.63				
* Covered & % Covered calculation- Refer at the end of validation sheet									
Design Shear Force			Depth- Cover- 20/2		Vu	1331.25	kN		
Effective depth of pilecap					Deff	1,045	mm		
Effective width of pile cap					Beff	2,400	mm		
Reinforcement required			Ast req/ (1000*Deff)		pt	0.0025			
design shear strength of concrete					Vu*d/Mu	1.00			
Check			Vu < φVc		φVc	1,425.87	clause 11.2.2.1	11.2.2.1 $V_c = (0.16\lambda_1/f_c^2 + 17\rho_w/M_u^2) b_w d$	
			Vu - φVc  / φ		Vs	-	clause 11.4.7.9		11.4.7.9 $0.66 \sqrt{f_c} b_w d$
Check			Vs > Vs perm		Vs perm	-			
<b>Shear Reinforcement Calculations</b>									
Area of shear reinforcement required			(Vs*1000/(Deff*fyt))*1000		Asv req	-	Sqmm		
Provided Shear reinforcement					Asv prv	-	Sqmm		
Shear capacity by Shear reinforcement			Asv prv* Deff* fyt		Vscap	-	kN		
Check			[φ * (Vc + Vs)] > Vu						
<b>Step 10)Design of Face reinforcement</b>									
Beff considered for SFR					Beff SFR	500	mm		
Area of side face reinf. Required			SFR% x D x Beff sfr		Asfr Req	281	Sqmm		
Area of side face reinf. Provided					Asfr pro	284	Sqmm		
<b>Step 11)Design For Column Load Transfer</b>									
Area of pilecap base			Area of Pilecap		A1	5.76	Clause 10.14	10.14.1 — Design bearing strength of concrete shall not exceed $\phi(0.85f_c A_1)$ , except when the supporting surface is wider on all sides than the loaded area. Then the design bearing strength of the loaded area shall be permitted to be multiplied by $\sqrt{A_2/A_1}$ , but by not more than 2.	
Area of column			Bc x Dc		A2	0.49	Clause 10.14		
Modification Factor			Sqrt(A1/A2)<=2			2	Clause 10.14		
Concrete Bearing capacity			φ <sub>1</sub> x 0.85 x Modification Factor x A2 x Fck x 1000		Φ <sub>1</sub> Pnb	10829	Clause 10.14		
Check			Φ <sub>1</sub> Pnb > Pu		SAFE				
Area Of Dowels					- sqmm				
<b>Calculation of Coverage</b>									
Consider an example shown above.									
Different conditions of section locations are marked as 1, 2 and 3									
1 Section line lies in b/w column and Pile considered									
2 Section line lies beyond the Pile considered									
3 Section line lies in the pile considered									
<b>Coverage Calculation</b>									
1 Coverage = Pile diameter since shear to be consider in the whole pile location = 600mm									
2 Coverage = 0 since the whole shear will be cancelled =0mm									
3 Coverage = Distance of section line from pile boundary									
E.g. Section location from centre of column = 882.5mm									
Diameter of Pile = 600mm									
Distance of pile centre from Column centre = 750mm									
Coverage = 882.5-(750-600/2) = 432.5mm									
<b>Coverage Percentage Calculation</b>									
1 100%									
2 0									
3 (100/Pile dia)*(Section location from centre of column-(Distance of Pile centre from column centre-Pile dia/2))									
= [(100/600)*(882.5-(750-600/2))] = 72.08%									