TITLE :	DESIGN OF PEDESTAL PILECAP					
SUB -TITLE :	DESIGN OF FOOTING FOR FLEXURE,SHEAR AND LOAD TRANSFER					
CODE OF PRACTICE :	ACI-318M-14					
CODE TITLE :	BUILDING CODE REQUIREMENT FOR STRUCTURAL CONCRETE					
DESIGN TYPE :	ULTIMATE STATE DESIGN					
NOTE :- 1) User to Input data in cell marked as Blue.						
2) Design follows Limit State Method.						
3) Forces of one section has been considered for design						
Step 1) User Input						
PARAMETERS :	SYMBOL	USER INPUT	UNITS	***Reference / Comments***		
Pilecap No		PC4				
Column No		C4				
characteristic compressive strength of concrete (Cylindrical Strength)	f'c	20.00	N/mm^2	*input from user*		
characteristic strength of reinforcement	fy	420.00	N/mm^2	*input from user*		
Cover to Bottom reinforcement	Cc	50.00	mm	*input from user*		
Diameter of Bottom reinforcement	dia1	19.10	mm	*input from user*		
Diameter of top reinforcement	dia2	15.90	mm	*input from user*		
Diameter of shear reinforcement along perpendicular direction	dia3	15.90	mm	*input from user*		
Diameter of shear reinforcement along parallel direction	dia3	19.10	mm	*input from user*		
Diameter of SFR	dia4	9.50	mm	*input from user*		
Number of legs for shear reinforcement		4	nos	*input from user*		
Minimum % steel at Bottom	ptmin	0.18	%	*input from user*		
Minimum % steel at Top	pcmin	0.18	%	*input from user*		
% SFR on each face		0.05	%	*input from user*		
Width of Column	Bc	700	mm	*input from user*		
Depth of Column	Dc	700	mm	*input from user*		
Density of Soil	ys	18.00	kN/cum	*input from user*		
Foundation depth	Df	4.00	m	*input from user*		
Depth of Water table below Ground level	Dw	-	m			
Pile capacity in Compression		1,500.00	kN	*input from user*		
Pile Capacity in Tension		500.00	kN	*input from user*		
Pile Capacity in Shear		200.00	kN	*input from user*		
Pile Capacity Reduction		0	%			
Pile Overloading		10	%	*input from user*		
Pile Group Overloading		10	%	*input from user*		
Self Weight multiplying factor for load check (Maximum load on one pile)		1.00		*input from user*		
Self Weight multiplying factor for load check (Maximum load on Pile Group)		1.00		*input from user*		
Self Weight multiplying factor for load check (Uplift load on pile)		1.00		*input from user*		
Self Weight multiplying factor for load check (Bottom reinf. Along Parallel Edge)		1.20		*input from user*		
Self Weight multiplying factor for load check (Bottom reinf. Along perpendicular Edge)		1.20		*input from user*		
Self Weight multiplying factor for load check (One way shear. Along parallel Edge)		1.20		*input from user*		
Self Weight multiplying factor for load check (Onnway shaer. Along perpendicular Edge)		1.20		*input from user*		
Capacity Increase Factor for SBC check (Eq / Wind)		0	%	*input from user*		
Consider Capacity Design		Yes		*input from user*		
Factor for Capacity Design		1.50		*input from user*		
Consider Overburden pressure		Yes		*input from user*		
Diameter of Pile	D	600	mm	*input from user*		
Number of piles		4	nos	*input from user*		
Pile Spacing (multiplication of diameter of pile)		2.50	xΦ	*input from user*		
Pile Spacing (Alternate pile spacing)		2.50	xΦ	*input from user*		
Pilecap offset		150	mm	*input from user*		
Depth of pilecap		1,125	mm	*input from user*		
Partial factor of safety for Moment	Φ1	0.90	constant	Clause 9.3.2.1 (Default)		
Partial factor of safety for Shear	Φ2	0.75	constant	Clause 9.3.2.3 (Default)		
Partial factor of safety for Bearing	Φ2.1	0.65	constant	Clause 9.3.2.4 (Default)		
Forces from Service load Combinations (maximum Load on one Pile)						
Governing Load combination		Lateral				
Axial Force	Pcomb	1,640.76	kN	*from analysis results*		
Moment along Major Direction	Mx	10.39	kN-m	*from analysis results*		
Moment along Minor Direction	My	-77.44	kN-m	*from analysis results*		
Forces from Service load Combinations (maximum Load on Pile Group)						
Axial Force	Pcomb	1,616.98	kN	*from analysis results*		
Moment along Major Direction	Mx	7.87	kN-m	*from analysis results*		
Moment along Minor Direction	My	-16.72	kN-m	*from analysis results*		
Forces from Service load Combinations (maximum Shear on one Pile)						
Governing Load combination		Lateral				
Shear along Major Direction	Vx	8.12	kN	*from analysis results*		
Shear along Minor Direction	Vy	38.76	kN	*from analysis results*		
Forces from Service load Combinations (Uplift on one pile)						
Governing Load combination		Lateral				
Axial Force	Pcomb	53.02	kN	*from analysis results*		
Moment along Major Direction	Mx	250.03	kN-m	*from analysis results*		
Moment along Minor Direction	My	278.04	kN-m	*from analysis results*		
Forces from Limit load Combinations (Bottom reinforcement Along parallel Edge)						
Axial Force	Pu	4,028.11	kN	*from analysis results*		
Moment along Major Direction	Mux	-0.35	kN-m	*from analysis results*		
Moment along Minor Direction	Muy	0.85	kN-m	*from analysis results*		
Forces from Limit load Combinations (Bottom reinforcement Along Perpendicular Edge)						
Axial Force	Pu	4,028.11	kN	*from analysis results*		
Moment along Major Direction	Mux	-0.35	kN-m	*from analysis results*		
Moment along Minor Direction	Muy	0.85	kN-m	*from analysis results*		
Forces from Limit load Combinations (One way shear-Along Parallel Edge)						
Axial Force	Pu	4,028.11	kN	*from analysis results*		
Moment along Major Direction	Mux	-0.35	kN-m	*from analysis results*		
Moment along Minor Direction	Muy	0.85	kN-m	*from analysis results*		
Forces from Limit load Combinations (One way shear-Along Perpendicular Edge)						
Axial Force	Pu	4,028.11	kN	*from analysis results*		
Moment along Major Direction	Mux	-0.35	kN-m	*from analysis results*		
Moment along Minor Direction	Muy	0.85	kN-m	*from analysis results*		
Forces from Limit load Combinations (Load Transfer Check)						
Axial Force	Pu	4,028.11	kN	*from analysis results*		
Moment along Major Direction	Mux	-0.35	kN-m	*from analysis results*		
Moment along Minor Direction	Muy	0.85	kN-m	*from analysis results*		
Detailing of Bottom/Top reinforcement						
Spacing of reinforcement at Bottom Along parallel edge		110		*input from user*		
Reinforcement diameter at Bottom along parallel edge		19.10	mm	*input from user*		
Spacing of reinforcement at Bottom Along perpendicular edge		105		*input from user*		
Reinforcement diameter at Bottom along perpendicular edge		19.10	mm	*input from user*		
Spacing of reinforcement at Top Along parallel edge		140		*input from user*		
Reinforcement diameter at Top Along parallel edge		19.10	mm	*input from user*		
Spacing of reinforcement at Top Along perpendicular edge		140	nos	*input from user*		
Reinforcement diameter at Top Along perpendicular edge		19.10	mm	*input from user*		
Shear Reinforcement						
Along Parallel edge						
Legs		7	mm			
Spacing		110	mm			
Along Perpendicular edge						
Legs		8	mm			
Spacing		110	mm			
SFR provided						
Number of SFR		4	nos			
charactersitic yield strength of reinforcement for shear	fyt	420.00	N/mm^2	clause 11.4.2		
Effective depth for bottom Reinforcement	deff1	1,065.00	mm			
Step 2) Pile and Pile group capacities						
Pile Capacity	Ppile axial	1,500	kN			
Pile Group Capacity	Pgroup	6600	kN			
Pile Group Capacity in shear	Ppile shear	200	kN			
Pile capacity in tension	Ppile tension	500	kN			

9.3.2.1 — Tension-controlled sections
Strength reduction factor ϕ 0.90

9.3.2.3 — Shear and torsion 0.75

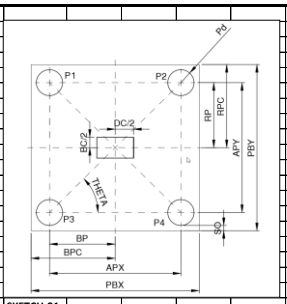
9.3.2.4 — Bearing on concrete (except for post-tensioned anchorage zones and strut-and-tie models) 0.65

11.4.2 — The values of f_y and f_{yt} used in design of shear reinforcement shall not exceed 420 MPa

Step 3) Pilecap confirguration 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	Rp	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



SKETCH-01

Step 4) Check for maximum load on one pile

Forces On Piles

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			548.15	kN
Allowable load on pile			1,650	kN
Check			OK	

Step 5) Check for maximum load on pile group

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			2,051.70	kN
Allowabl load on pile group		Pgroup	6,600	kN
Check			OK	

Step 6) Check for maximum shear on pile group

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			`	

Step 7) Check for uplift on one pile

No uplift in any pile

Step 8)Design for Bending

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
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))		1,137.61	kN
Max Load on pile			1,137.84	kN

Bottom reinforcement Along Column D

Effective depth of pilecap	Depth-Cover-20-20/2	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		Bmux	900.00	kN-m
% reinf. Required for Bending moment		Ptreq	0.24	%
% minimum reinforcement		Pt min	0.18	%
Area of reinf. Required		Ast Req (BM)	2,560.06	sqmm/m
Area of reinforcement provided		Ast prv	2,604.74	sqmm/m

Top reinforcement Along Column D

Area of reinf. Required		Ast req	2025.00	sqmm/m
Area of reinforcement provided		Ast provided	2046.58	sqmm/m
		Check	OK	

Bottom reinforcement Along Column 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
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))		1137.61	kN
Max Load on pile			1137.84	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		Bmux	900.00	kN-m
% reinf. Required for Bending moment		Ptreq	0.25	%
% minimum reinforcement		Pt min	0.18	%
Area of reinf. Required		Ast Req (BM)	2612.25	sqmm/m
Area of reinforcement provided		Ast prv	2728.77	sqmm/m

Top reinforcement Along Column B

Area of reinf. Required		Ast req	2025.00	sqmm/m
Area of reinforcement provided		Ast provided	2046.58	sqmm/m
		Check	OK	

Step 9)Design for Shear

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
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))		1137.61	kN
Max Load on pile			1,137.84	kN

Along Column D

Section location from column center			882.50	mm

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

Design Shear Force		Vu	1256.25	kN
Effective depth of pilecap	Depth-Cover-20-20/2	Deff	1,065	mm
Effective width of pile cap		Beff	2,400.00	mm
Reinforcement required		pt	0.0024	
		Vu*d/Mu	1.00	
design shear strength of concrete		ϕVc	1,450.03	kN
Check	Vu < ϕVc		OK	
		Vs	-	kN
		Vs perm	-	kN
			-	

11.2.2.1 $V_c = \left(0.16\lambda\sqrt{f'_c} + 17\rho_w \frac{V_u d}{M_u}\right) b_w d$ – $0.29\lambda\sqrt{f'_c}\, b_w d$

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

Shear Reinforcement Calculations

Area of shear reinforcement required		Asv req	-	sqmm/m
Provided Shear reinforcement		Asv prv	-	sqmm/m
Shear capacity by Shear reinforcment		Vscap	-	kN
Check (ϕ * (Vc + Vs) > Vu)			-	

Along column 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		
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					
Design Shear Force							1331.25	kN		
Effective depth of pilecap						Deff	1,045	mm		
Effective width of pile cap						Beff	2,400	mm		
Reinforcement required						pt	0.0025			
						Vu*d/Mu	1.00			
						ϕVc	1,425.87	kN	clause 11.2.2.1	
							OK			
						Vs	-	kN		
						Vs perm	-	kN	clause 11.4.7.9	
							-			
Shear Reinforcement Calculations										
Area of shear reinforcement required						Asv req	-	Sqmm		
Provided Shear reinforcement						Asv prv	-	Sqmm		
Shear capacity by Shear reinforcment						Vscap	-	kN		
Check (ϕ * (Vc + Vs) > Vu)							-			
Step 10)Design of Face reinforcement										
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		
Step 11)Design For Column Load Transfer										
Area of pilecap base					Area of Pilecap	A1	5.76	sqm	*Clause 10.14*	
Area of column					Bc x Dc	A2	0.49	sqm	*Clause 10.14*	
Modification Factor					Sqrt(A1/A2)<=2		2		*Clause 10.14*	
Concrete Bearing capacity				Φ_1 x 0.85 x Modification Factor x A2 x Fck x 1000			10829	kN	*Clause 10.14*	
Check							OK			
Area Of Dowels							-	sqmm		

11.2.2.1 $V_c = \left(0.16\lambda\sqrt{f'_c} + 17\rho_w\frac{V_u d}{M_u}\right)b_w d$ but $\leq 0.29\lambda\sqrt{f'_c}\,b_w d$

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

10.14 — Bearing strength

10.14.1 — Design bearing strength of concrete shall not exceed $\phi(0.85f'_cA_1)$, 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.