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			PC6			
Column No			C6			
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	25.40	mm	*input from user*	
Diameter of top reinforcement		dia2	25.40	mm	*input from user*	
Diameter of shear reinforcement along perpendicular direction		dia3	9.50	mm	*input from user*	
Diameter of shear reinforcement along parallel direction		dia3	9.50	mm	*input from user*	
Diameter of SFR		dia4	9.50	mm	*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			2,000.00	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			5	%	*input from user*	
Pile Group Overloading			5	%	*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			6	nos	*input from user*	
Pile Spacing (multiplication of diameter of pile)			2.50	xΦ	*input from user*	
Pilecap offset			150	mm	*input from user*	
Depth of pilecap			2,050	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	1,761.07	kN	*from analysis results*	
Moment along Major Direction		Mx	-82.74	kN-m	*from analysis results*	
Moment along Minor Direction		My	-15.06	kN-m	*from analysis results*	
Forces from Service load Combinations (maximum Load on Pile Group)						
Axial Force		Pcomb	1,774.25	kN	*from analysis results*	
Moment along Major Direction		Mx	-16.73	kN-m	*from analysis results*	
Moment along Minor Direction		My	-15.74	kN-m	*from analysis results*	
Forces from Service load Combinations (maximum Shear on one Pile)						
Governing Load combination			Lateral			
Shear along Major Direction		Vx	50.59	kN	*from analysis results*	
Shear along Minor Direction		Vy	-6.14	kN	*from analysis results*	
Forces from Service load Combinations (Uplift on one pile)						
Governing Load combination			Lateral			
Axial Force		Pcomb	3,155.60	kN	*from analysis results*	
Moment along Major Direction		Mx	-14.99	kN-m	*from analysis results*	
Moment along Minor Direction		My	-0.94	kN-m	*from analysis results*	
Forces from Limit load Combinations (Bottom reinforcement Along parallel Edge)						
Axial Force		Pu	4,063.08	kN	*from analysis results*	
Moment along Major Direction		Mux	-20.41	kN-m	*from analysis results*	
Moment along Minor Direction		Muy	-1.60	kN-m	*from analysis results*	
Forces from Limit load Combinations (Bottom reinforcement Along Perpendicular Edge)						
Axial Force		Pu	4,063.08	kN	*from analysis results*	
Moment along Major Direction		Mux	-20.41	kN-m	*from analysis results*	
Moment along Minor Direction		Muy	-1.60	kN-m	*from analysis results*	
Forces from Limit load Combinations (One way shear-Along Parallel Edge)						
Axial Force		Pu	4,063.08	kN	*from analysis results*	
Moment along Major Direction		Mux	-20.41	kN-m	*from analysis results*	
Moment along Minor Direction		Muy	-1.60	kN-m	*from analysis results*	
Forces from Limit load Combinations (One way shear-Along Perpendicular Edge)						
Axial Force		Pu	4,063.08	kN	*from analysis results*	
Moment along Major Direction		Mux	-20.41	kN-m	*from analysis results*	
Moment along Minor Direction		Muy	-1.60	kN-m	*from analysis results*	
Forces from Limit load Combinations (Load Transfer Check)						
Axial Force		Pu	4,063.08	kN	*from analysis results*	
Moment along Major Direction		Mux	-20.41	kN-m	*from analysis results*	
Moment along Minor Direction		Muy	-1.60	kN-m	*from analysis results*	
Detailing of Bottom/Top reinforcement						
Spacing of reinforcement at Bottom Along parallel edge			120		*input from user*	
Reinforcement diameter at Bottom along parallel edge			28.70	mm	*input from user*	
Number of reinforcement at Bottom Along perpendicular edge			115		*input from user*	
Reinforcement diameter at Bottom along perpendicular edge			25.40	mm	*input from user*	
Number of reinforcement at Top Along parallel edge			135		*input from user*	
Reinforcement diameter at Top Along parallel edge			25.40	mm	*input from user*	
Number of reinforcement at Top Along perpendicular edge			135	nos	*input from user*	
Reinforcement diameter at Top Along perpendicular edge			25.40	mm	*input from user*	
Shear Reinforcement						
Along Parallel edge						
Legs			-			
Spacing			100	mm		
Along Perpendicular edge						
Legs			-			
Spacing			105	mm		
SFR provided						
Number of SFR			8	nos		
characterstic yield strength of reinforcement for shear		fyt	420.00	N/mm^2	clause 11.4.2	
Effective depth for bottom Reinforcement		deff1	1,990.00	mm		
Step 2) Pile and Pile group capacities						
Pile Capacity		Ppile axial	2,000	kN		
Pile Group Capacity		Pgroup	12600	kN		
Pile Group Capacity in shear		Ppile shear	200	kN		
Pile capacity in tension		Ppile tension	500	kN		
c/c distance of pile, 'Ap'			1500	mm		

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)

					(360/No of Piles)*PI()/180	Phi	1.047	Radian							
					(180-(360/No of Piles))/2*PI()/180	Theta	1.047	Radian							
					D * Pile spacing	Ap	1,500.00	mm							
					(Ap/2)*TAN(Theta)	Bp	1,299.04	mm							
					SQRT((Ap/2)^2+(Bp^2))	Rp	1500.00	mm							
Pile-cap Base					Ap*Cos(Phi)	Cp	750.00	mm							
					Ap*Sin(Phi)	Dp	1,299.04	mm							
					(Bp+Offset+(D/2))/Bp*Ap	Pb	2,020	mm							
					Bp+ Offset+ D/2	Bpc	1749.04	mm							
					SQRT((Pb/2)^2+(Bpc^2))	Rpc	2019.62	mm							
					Pb*Cos(Phi)	Cpc	1009.81	mm							
					Pb*Sin(Phi)	Dpc	1749.04	mm							
Area of pilecap					Area of pilecap		10597152	sqmm							
Position of Piles		**Px**	**Py**												
P1		750	1299												
P2		750	1299												
P3		1500	0												
P4		1500	0												
P5		750	1299												
P6		750	1299												
Step 4) Check for maximum load on one pile															
Forces On Piles															
Weight of pilecap + Overburden weight of soil					Soil Wt + Pilecap Wt		897.87	kN							
Total Weight on Pile					Pcomb + Soil Wt + Pilecap Wt	Ptotal	2,658.94	kN	P	PMx	PMy				
Load transfer to pile P1							455.25	kN	443.16	9.19	2.90				
Load transfer to pile P2							436.86	kN	443.16	-9.19	2.90				
Load transfer to pile P3							461.54	kN	443.16	18.39	0.00				
Load transfer to pile P4							424.77	kN	443.16	-18.39	0.00				
Load transfer to pile P5							449.45	kN	443.16	9.19	-2.90				
Load transfer to pile P6							431.06	kN	443.16	-9.19	-2.90				
Ptotal															
Maximum load on one pile							461.54	kN							
Allowable load on pile							2,100	kN							
Check							OK								
Step 5) Check for maximum load on pile group					Soil Wt + Pilecap Wt										
Weight of pilecap + Overburden weight of soil					Pcomb + Soil Wt + Pilecap Wt	Ptotal	897.865	kN							
Total Weight on Pile							2,672.12	kN							
Maximum load on pile group						Pgroup	2,672.12	kN							
Allowabl load on pile group							12,600	kN							
Check							OK								
Step 6) Check for maximum shear on pile group															
Maximum shear on pile group					Sqrt (Vx^2 + Vy^2)		50.96	kN							
Shear Capacity of pile group					Shear capacity x No of piles	Ppile shear	1,200	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		1077.44	kN							
Total Weight on Pile					Pcomb + Soil Wt + Pilecap Wt	Ptotal	5,140.52	kN							
Forces On Piles									P	PMx	PMy				
Load transfer to pile P1							3,000.00	kN	856.75	2.27	0.31				
Load transfer to pile P2							3,000.00	kN	856.75	-2.27	0.31				
Load transfer to pile P3							3,000.00	kN	856.75	4.54	0.00				
Load transfer to pile P4							3,000.00	kN	856.75	-4.54	0.00				
Load transfer to pile P5							3,000.00	kN	856.75	2.27	-0.31				
Load transfer to pile P6							3,000.00	kN	856.75	-2.27	-0.31				
Max Load on pile							3,000.00	kN							
Bottom reinforcement Along Parallel Edge															
Effective depth of pilecap					Depth-Cover-20-20/2	Deff	1,990.00	mm							
Effective width of pile cap					Pile dia+ 2*Offset	Beff	900	mm							
offset from column face					(Apx/2-Dc/2)/1000	DfCol	1.15	m							
Bending moment due to pile load						Bmux	3450.00	kN-m							
% reinf. Required for Bending moment						Ptreq	0.26	%							
% minimum reinforcement						Pt min	0.18	%							
Area of reinf. Required						Ast Req (BM)	5,268	sqmm/m							
Area of reinforcement provided						Ast prv	5,391.04	sqmm/m							
Top reinforcement Along Parallel Edge															
Area of reinf. Required						Ast req	3690	sqmm/m							
Area of reinforcement provided						Ast provided	3753	sqmm/m							
						Check	OK								
Bottom reinforcement Along Perpendicular Edge															
Weight of pilecap + Overburden weight of soil					Soil Wt + Pilecap Wt		1077.44	kN							
Total Weight on Pile					Pcomb + Soil Wt + Pilecap Wt	Ptotal	5,140.52	kN							
Forces On Piles									P	PMx	PMy				
Load transfer to pile P1							3,000.00	kN	856.75	2.27	0.31				
Load transfer to pile P2							3,000.00	kN	856.75	-2.27	0.31				
Load transfer to pile P3							3,000.00	kN	856.75	4.54	0.00				
Load transfer to pile P4							3,000.00	kN	856.75	-4.54	0.00				
Load transfer to pile P5							3,000.00	kN	856.75	2.27	-0.31				
Load transfer to pile P6							3,000.00	kN	856.75	-2.27	-0.31				
Max Load on pile							3,000.00	kN							
Effective depth of pilecap					Depth-Cover-20-20/2	Deff	1,970	mm							
Effective width of pile cap					Pile dia+ 2*Offset	Beff	900	mm							
offset from column face					(Apy/2-Bc/2)/1000	DfCol	0.95	m							
Bending moment due to pile load						Bmux	2847.11	kN-m							
% reinf. Required for Bending moment						Ptreq	0.22	%							
% minimum reinforcement						Pt min	0.18	%							
Area of reinf. Required						Ast Req (BM)	4,368	sqmm/m							
Area of reinforcement provided						Ast prv	4406	sqmm/m							
Top reinforcement Along Perpendicular Edge															
Area of reinf. Required						Ast req	3690	sqmm/m							
Area of reinforcement provided						Ast provided	3753	sqmm/m							
						Check	OK								
Step 9)Design for Shear															
Weight of pilecap + Overburden weight of soil					Soil Wt + Pilecap Wt		1077.44	kN							
Total Weight on Pile					Pcomb + Soil Wt + Pilecap Wt	Ptotal	5,140.52	kN							
Forces On Piles									P	PMx	PMy				
Load transfer to pile P1							3,000.00	kN	856.75	2.27	0.31				
Load transfer to pile P2							3,000.00	kN	856.75	-2.27	0.31				
Load transfer to pile P3							3,000.00	kN	856.75	4.54	0.00				
Load transfer to pile P4							3,000.00	kN	856.75	-4.54	0.00				
Load transfer to pile P5							3,000.00	kN	856.75	2.27	-0.31				
Load transfer to pile P6							3,000.00	kN	856.75	-2.27	-0.31				
Along Parallel Edge															
Section location from column center							1,345.00	mm							
Data For Pile															
Pile No	Load (kN)		Covered(mm)	% covered	Shear(kN)										
P1	3,000.00	1	0	0.00	0.00										
P2	3,000.00	1	0	0.00	0.00										
P3	3,000.00	2	145	149.17	2275.00										
P4	3,000.00	2	145	24.17	2275.00										
P5	3,000.00	1	0	0.00	0.00										
P6	3,000.00	1	0	0.00	0.00										

Design Shear Force					Vu	2275.00	kN						
Effective depth of pilecap				Depth-Cover-20-20/2	Deff	1,990	mm						
Slope for edge P1-P3						1.73205							
Effective width of pile cap					Beff	2,336.94	mm						
Reinforcement required					pt	0.0026							
					Vu*d/Mu	1.00							
design shear strength of concrete					ϕVc	2,652.70	kN	clause 11.2.2.1					
Check						OK							
					Vs	-	kN						
					Vs perm	-	kN	clause 11.4.7.9					
						-							
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 Perpendicular Edge													
Weight of pilecap + Overburden weight of soil				Soil Wt + Pilecap Wt		1077.44	kN						
Total Weight on Pile				Pcomb + Soil Wt + Pilecap Wt	Ptotal	5,140.52	kN						
Forces On Piles								P	PMx	PMy			
Load transfer to pile P1						3,000.00	kN	856.75	2.27	0.31			
Load transfer to pile P2						3,000.00	kN	856.75	-2.27	0.31			
Load transfer to pile P3						3,000.00	kN	856.75	4.54	0.00			
Load transfer to pile P4						3,000.00	kN	856.75	-4.54	0.00			
Load transfer to pile P5						3,000.00	kN	856.75	2.27	-0.31			
Load transfer to pile P6						3,000.00	kN	856.75	-2.27	-0.31			
Section location from column center						1,335.0	mm						

Pile No	Load (kN)		Covered(mm)	% covered	Shear(kN)
P1	3,000.00	2	336	55.99	1320.19
P2	3,000.00	2	336	55.99	1320.19
P3	3,000.00	1	0	0.00	0.00
P4	3,000.00	1	0	0.00	0.00
P5	3,000.00	2	336	55.99	1320.19
P6	3,000.00	2	336	55.99	1320.19

Design Shear Force					Vu	2640.38	kN						
Effective depth of pilecap					Deff	1,970	mm						
shear due to P1+P2+P3						2,640	kN						
Slope for edge P1+P2+P3						0.577	mm						
Effective width of pile cap for P1+P2						2,497.71	mm						
Reinforcement required					pt	0.0022	ratio						
					Vu*d/Mu	1.00							
					ϕVc	2,779.70	kN	clause 11.2.2.1					
						OK							
					Vs	-							
					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	512.5	Sqmm						
Area of side face reinf. Provided					Asfr pro	567.06	Sqmm						
Step 11)Design For Column Load Transfer													
Area of pilecap base				Area of Pilecap	A1	10.60	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 $\phi(0.85 f'_c A_1)$, 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.