| | | | | |
|---|---|---|---|---|
| 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 | | PC5 | | |
| Column No | | C5 | | |
| 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* |
| Number of legs for shear reinforcement | | 5 | 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 | | 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 | | 10 | % | *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) | | 1.50 | | *input from user* |
| Self Weight multiplying factor for load check (Bottom reinf. Along perpendicular Edge) | | 1.50 | | *input from user* |
| Self Weight multiplying factor for load check (One way shear. Along parallel Edge) | | 1.50 | | *input from user* |
| Self Weight multiplying factor for load check (Onnway shaer. Along perpendicular Edge) | | 1.50 | | *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 | | 5 | 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 | | 1,875 | 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 | 1,199.31 | kN | *from analysis results* |
| Moment along Major Direction | Mx | 85.88 | kN-m | *from analysis results* |
| Moment along Minor Direction | My | -22.85 | kN-m | *from analysis results* |
| **Forces from Service load Combinations (maximum Load on Pile Group)** | | | | |
| Axial Force | Pcomb | 1,181.78 | kN | *from analysis results* |
| Moment along Major Direction | Mx | 23.42 | kN-m | *from analysis results* |
| Moment along Minor Direction | My | -22.11 | kN-m | *from analysis results* |
| **Forces from Service load Combinations (maximum Shear on one Pile)** | | | | |
| Governing Load combination | | Lateral | | |
| Shear along Major Direction | Vx | 13.85 | kN | *from analysis results* |
| Shear along Minor Direction | Vy | 41.81 | 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 | 3,927.73 | kN | *from analysis results* |
| Moment along Major Direction | Mux | 11.00 | kN-m | *from analysis results* |
| Moment along Minor Direction | Muy | -5.36 | kN-m | *from analysis results* |
| **Forces from Limit load Combinations (Bottom reinforcement Along Perpendicular Edge)** | | | | |
| Axial Force | Pu | 3,927.73 | kN | *from analysis results* |
| Moment along Major Direction | Mux | 11.00 | kN-m | *from analysis results* |
| Moment along Minor Direction | Muy | -5.36 | kN-m | *from analysis results* |
| **Forces from Limit load Combinations (One way shear-Along Parallel Edge)** | | | | |
| Axial Force | Pu | 3,927.73 | kN | *from analysis results* |
| Moment along Major Direction | Mux | 11.00 | kN-m | *from analysis results* |
| Moment along Minor Direction | Muy | -5.36 | kN-m | *from analysis results* |
| **Forces from Limit load Combinations (One way shear-Along Perpendicular Edge)** | | | | |
| Axial Force | Pu | 4,838.40 | kN | *from analysis results* |
| Moment along Major Direction | Mux | 704.61 | kN-m | *from analysis results* |
| Moment along Minor Direction | Muy | -17.30 | 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 | | 115 | | *input from user* |
| Reinforcement diameter at Bottom along parallel edge | | 25.40 | mm | *input from user* |
| Number of reinforcement at Bottom Along perpendicular edge | | 105 | | *input from user* |
| Reinforcement diameter at Bottom along perpendicular edge | | 25.40 | mm | *input from user* |
| Number of reinforcement at Top Along parallel edge | | 150 | | *input from user* |
| Reinforcement diameter at Top Along parallel edge | | 25.40 | mm | *input from user* |
| Number of reinforcement at Top Along perpendicular edge | | 150 | nos | *input from user* |
| Reinforcement diameter at Top Along perpendicular edge | | 25.40 | mm | *input from user* |
| **Shear Reinforcement** | | | | |
| Along Parallel edge | | | | |
| Legs | | 5 | nos | |
| Spacing | | 100 | mm | |
| Along Perpendicular edge | | | | |
| Legs | | 5 | nos | |
| Spacing | | 105 | mm | |
| SFR provided | | | | |
| Number of SFR | | 6 | nos | |
| characterstic yield strength of reinforcement for shear | fyt | 420.00 | $N/mm^2$ | clause 11.4.2 |
| Effective depth for bottom Reinforcement | deff1 | 1,815.00 | mm | |
| **Step 2) Pile and Pile group capacities** | | | | |
| Pile Capacity | Ppile axial | 2,000 | kN | |
| Pile Group Capacity | Pgroup | 10500 | 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 $\phi$ .....0.90

**9.3.2.3** — Shear and torsion .....0.75

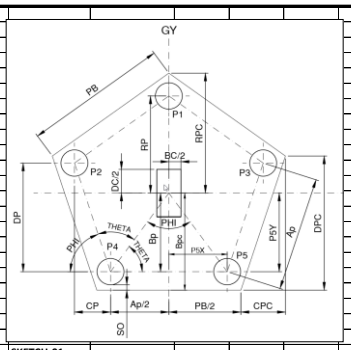
**9.3.2.4** — Bearing on concrete (except for post-tensioned anchorage zones and strut-and-tie models).....0.65

**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 | 1.257 | Radian | |
| | (180-(360/No of Piles))/2*PI()/180 | Theta | 0.942 | Radian | |
| | (Ap/2)* TAN(Theta) | Bp | 1,032.29 | mm | |
| | SQRT((Ap/2)^2+Bp^2) | Rp | 1275.98 | mm | |
| Pile-cap Base | Ap* COS(Phi) | Cp | 463.53 | mm | |
| | Ap* SIN(Phi) | Dp | 1,426.58 | mm | |
| | (Bp+Offset+ (D/2))/Bp*Ap | Pb | 2,153.89 | | |
| | Bp+ Offset+ D/2 | Bpc | 1482.29 | mm | |
| | SQRT((Pb/2)^2+Bpc^2) | Rpc | 1832.21 | mm | |
| | Pb* COS(Phi) | Cpc | 665.59 | mm | |
| | Pb* SIN(Phi) | Dpc | 2048.47 | mm | |
| Area of pilecap | Area of pilecap | | 7981698 | sqmm | |

| Position of Piles | Px | Py |
|---|---|---|
| P1 | 0 | 1276 |
| P2 | 1,213.53 | 394 |
| P3 | 1,213.53 | 394 |
| P4 | 750.00 | 1032 |
| P5 | 750.00 | 1032 |




**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 | | 660.70 | kN | | | | |
| Total Weight on Pile | | | | Pcomb + Soil Wt + Pilecap Wt | Ptotal | 1,860.01 | kN | | P | PMx | PMy |
| Load transfer to pile P1 | | | | P+ PMx+ PMy of P1 | | 345.08 | kN | P1 | 372.00 | -26.92 | 0 |
| Load transfer to pile P2 | | | | P+ PMx+ PMy of P2 | | 370.50 | kN | P2 | 372.00 | -8.32 | 6.81 |
| Load transfer to pile P3 | | | | P+ PMx+ PMy of P3 | | 356.87 | kN | P3 | 372.00 | -8.32 | -6.81 |
| Load transfer to pile P4 | | | | P+ PMx+ PMy of P4 | | 397.99 | kN | P4 | 372.00 | 21.78 | 4.21 |
| Load transfer to pile P5 | | | | P+ PMx+ PMy of P5 | | 389.57 | kN | P5 | 372.00 | 21.78 | -4.21 |
| Ptotal | | | | | | | | | | | |
| Maximum load on one pile | | | | Max Load transfer to (P1,P2,P3,P4,P5) | | 397.99 | kN | P = | Ptotal/ No of Piles | | |
| Allowable load on pile | | | | | | 2,100 | kN | PMx = | Axial Load on Pile due to moment Mx | | = Moment/ Lever arm b/w piles |
| Check | | | | Max load on one pile < All. load on one Pile | | OK | | | ((Mx*(Bp/1000)/((Rp/1000)^2+2*(Dp/1000-Bp/1000)^2+2*(Bp/1000)^2))*Rp/Bp) | | |
| | | | | | | | | Pmy = | Axial Load on Pile due to moment My | | = Moment/ Lever arm b/w piles |

**Step 5) Check for maximum load on pile group**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | My*(Ap/1000/2+Cp/1000)/(2*(Ap/1000/2)^2+2*(Ap/1000/2+Cp/1000)^2)) | | |
| Weight of pilecap + Overburden weight of soil | | | | Soil Wt + Pilecap Wt | | 660.700 | kN | | | | |
| Total Weight on Pile | | | | Pcomb + Soil Wt + Pilecap Wt | Ptotal | 1,842.48 | kN | (The formulas of PMx and PMy above is of first pile P1. | | | |
| Maximum load on pile group | | | | | | 1,842.48 | kN | Refere the SKETCH-01 above for the terms in the formula) | | | |
| Allowabl load on pile group | | | | | | 10,500 | kN | | | | |
| Check | | | | Max load on pilegroup < All. load on Pilegroup | | OK | | | | | |

**Step 6) Check for maximum shear on pile group**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum shear on pile group | | | | Sqrt (Vx^2 + Vy^2) | | 44.04 | kN | | | | |
| Shear Capacity of pile group | | | | Shear capacity x No of piles | Ppile shear | 1,000 | kN | | | | |
| Check | | | | Max shear on pilegroup < All. shear on Pilegroup | | OK | | | | | |

**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 | | 991.05 | kN | | | | |
| Total Weight on Pile | | | | Pcomb + Soil Wt + Pilecap Wt | Ptotal | 4,918.78 | kN | | | | |
| Forces On Piles | | | | | | | | | P | PMx | PMy |
| Load transfer to pile P1 | | | | P+ PMx+ PMy of P1 | | 3,000.00 | kN | P1 | 983.76 | -3.45 | 0.00 |
| Load transfer to pile P2 | | | | P+ PMx+ PMy of P2 | | 3,000.00 | kN | P2 | 983.76 | -1.07 | 1.60 |
| Load transfer to pile P3 | | | | P+ PMx+ PMy of P3 | | 3,000.00 | kN | P3 | 983.76 | -1.07 | -1.60 |
| Load transfer to pile P4 | | | | P+ PMx+ PMy of P4 | | 3,000.00 | kN | P4 | 983.76 | 2.79 | 0.99 |
| Load transfer to pile P5 | | | | P+ PMx+ PMy of P5 | | 3,000.00 | kN | P5 | 983.76 | 2.79 | -0.99 |
| Max Load on pile | | | | Max Load transfer to (P1,P2,P3,P4,P5) | | 3,000.00 | kN | | | | |
| **Bottom reinforcement Along Parallel Edge** | | | | | | | | | P, PMx and PMy - refer in "Check for Maximum load on Pile" part | | |
| Effective depth of pilecap | | | | Depth-Cover-20-20/2 | Deff | 1,795.00 | mm | | | | |
| Effective width of pile cap | | | | Pile dia+ 2*Offset | Beff | 900 | mm | | | | |
| offset from column face | | | | (Apx/2-Dc/2)/1000 | DfCol | 0.86 | m | | | | |
| Bending moment due to pile load | | | | P * DfCol | Bmux | 2590.58 | 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))))*100 | | Ptreq | 0.24 | % | | | | |
| % minimum reinforcement | | | | | Pt min | 0.18 | % | 8.6.1.1 | | | |
| Area of reinf. Required | | | | Pt *Deff *1000 | Ast Req (BM) | 4,374 | sqmm/m | | | | |
| Area of reinforcement provided | | | | | Ast prv | 4,406.15 | sqmm/m | | | | |
| Check | | | | Ast provided > Ast req | | OK | | | | | |
| **Top reinforcement Along Parallel Edge** | | | | | | | | | | | |
| Area of reinf. Required | | | | Pt *Deff *1000 | Ast req | 3375.00 | sqmm/m | | | | |
| Area of reinforcement provided | | | | | Ast provided | 3378.05 | sqmm/m | | | | |
| Check | | | | Ast provided > Ast req | | OK | | | | | |

**Bottom reinforcement Along Perpendicular Edge**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight of pilecap + Overburden weight of soil | | | | Soil Wt + Pilecap Wt | | 991.05 | kN | | | | |
| Total Weight on Pile | | | | Pcomb + Soil Wt + Pilecap Wt | Ptotal | 4,918.78 | kN | | | | |
| Forces On Piles | | | | | | | | | P | PMx | PMy |
| Load transfer to pile P1 | | | | P+ PMx+ PMy of P1 | | 3,000.00 | kN | P1 | 983.76 | -3.45 | 0.00 |
| Load transfer to pile P2 | | | | P+ PMx+ PMy of P2 | | 3,000.00 | kN | P2 | 983.76 | -1.07 | 1.60 |
| Load transfer to pile P3 | | | | P+ PMx+ PMy of P3 | | 3,000.00 | kN | P3 | 983.76 | -1.07 | -1.60 |
| Load transfer to pile P4 | | | | P+ PMx+ PMy of P4 | | 3,000.00 | kN | P4 | 983.76 | 2.79 | 0.99 |
| Load transfer to pile P5 | | | | P+ PMx+ PMy of P5 | | 3,000.00 | kN | P5 | 983.76 | 2.79 | -0.99 |
| Max Load on pile | | | | Max Load transfer to (P1,P2,P3,P4,P5) | | 3,000.00 | kN | | | | |
| | | | | | | | | | P, PMx and PMy - refer in "Check for Maximum load on Pile" part | | |
| Effective depth of pilecap | | | | Depth-Cover-20-20/2 | Deff | 1,815 | mm | | | | |
| Effective width of pile cap | | | | Pile dia+ 2*Offset | Beff | 900 | mm | | | | |
| offset from column face | | | | (Apy/2-Bc/2)/1000 | DfCol | 0.93 | m | | | | |
| Bending moment due to pile load | | | | P * DfCol | Bmux | 2777.93 | 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))))*100 | | Ptreq | 0.26 | % | | | | |
| % minimum reinforcement | | | | | Pt min | 0.18 | % | 8.6.1.1 | | | |
| Area of reinf. Required | | | | Pt *Deff *1000 | Ast Req (BM) | 4645.84 | sqmm/m | | | | |
| Area of reinforcement provided | | | | | Ast prv | 4825.79 | sqmm/m | | | | |
| Check | | | | Ast provided > Ast req | | OK | | | | | |
| **Top reinforcement Along Perpendicular Edge** | | | | | | | | | | | |
| Area of reinf. Required | | | | Pt *Deff *1000 | Ast req | 3375 | sqmm/m | | | | |
| Area of reinforcement provided | | | | | Ast provided | 3378 | sqmm/m | | | | |
| Check | | | | Ast provided > Ast req | | OK | | | | | |

**Step 9)Design for Shear**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight of pilecap + Overburden weight of soil | | | | Soil Wt + Pilecap Wt | | 991.05 | kN | | | | |
| Total Weight on Pile | | | | Pcomb + Soil Wt + Pilecap Wt | Ptotal | 4,918.78 | kN | | | | |
| Forces On Piles | | | | | | | | | P | PMx | PMy |
| Load transfer to pile P1 | | | | P+ PMx+ PMy of P1 | | 3,000.00 | kN | P1 | 983.76 | -3.45 | 0.00 |
| Load transfer to pile P2 | | | | P+ PMx+ PMy of P2 | | 3,000.00 | kN | P2 | 983.76 | -1.07 | 1.60 |
| Load transfer to pile P3 | | | | P+ PMx+ PMy of P3 | | 3,000.00 | kN | P3 | 983.76 | -1.07 | -1.60 |
| Load transfer to pile P4 | | | | P+ PMx+ PMy of P4 | | 3,000.00 | kN | P4 | 983.76 | 2.79 | 0.99 |
| Load transfer to pile P5 | | | | P+ PMx+ PMy of P5 | | 3,000.00 | kN | P5 | 983.76 | 2.79 | -0.99 |
| | | | | | | | | | P, PMx and PMy - refer in "Check for Maximum load on Pile" part | | |

**Along Parallel Edge**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Section location from column center | | | | | | 1,247.50 | mm |
| Data For Pile | | | | | | | |
| Pile No | Load (kN) | | Covered(mm) | % covered | Shear(kN) | | |
| P1 | 3,000.00 | 1 | 0 | 0.00 | 0.00 | Covered | |
| P2 | 3,000.00 | 2 | 333.9745084 | 55.66 | 1330.13 | | |
| P3 | 3,000.00 | 2 | 333.9745084 | 55.66 | 1330.13 | | |
| P4 | 3,000.00 | 1 | 0 | 0.00 | 0.00 | | |
| P5 | 3,000.00 | 1 | 0 | 0.00 | 0.00 | | |

* Covered & % Covered calculation- Refer 4piles validation sheet

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Design Shear Force | | | | | | Vu | 1330.13 | kN | | | | | | | | |
| Effective depth of pilecap | | | | | Depth-Cover-20-20/2 | Deff | 1,795 | mm | | | | | | | | |
| Slope for edge P1-P3 | | | | | | | 0.72654 | | | | | | | | | |
| Slope for edge P5-P3 | | | | | | | 3.0777 | | | | | | | | | |
| Effective width of pile cap | | | | | | Beff | 1,883.21 | mm | | | | | | | | |
| Reinforcement required | | | | | Ast req/ (1000*Deff) | pt | 0.0024 | | | | | | | | | |
| | | | | | | Vu*d/Mu | 0.92 | | | | | | | | | |
| design shear strength of concrete | | | | | | ϕVc | 1,910.89 | kN | clause 11.2.2.1 | | | | | | | |
| Check | | | | | Vu < ϕVc | | OK | | | | | | | | | |
| | | | | | (Vu - ϕVc)/ ϕ | Vs | - | kN | | | | | | | | |
| | | | | | | Vs perm | - | kN | clause 11.4.7.9 | | | | | | | |
| Check | | | | | Vs > Vs perm | | - | | | | | | | | | |
| **Shear Reinforcement Calculations** | | | | | | | | | | | | | | | | |
| 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 reinforcment | | | | | Asv prv* Deff* fyt | Vscap | - | kN | | | | | | | | |
| Check | | | | | [ϕ * (Vc + Vs)] > Vu | | - | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Along Perpendicular Edge** | | | | | | | | | | | | | | | | |
| Weight of pilecap + Overburden weight of soil | | | | | Soil Wt + Pilecap Wt | | 991.05 | kN | | | | | | | | |
| Total Weight on Pile | | | | | Pcomb + Soil Wt + Pilecap Wt | Ptotal | 5,829.45 | kN | | | | | | | | |
| Forces On Piles | | | | | | | | | | P | PMx | PMy | | | | |
| Load transfer to pile P1 | | | | | P+ PMx+ PMy of P1 | | 3,000.00 | kN | P1 | 1165.89 | -220.88 | 0.00 | | | | |
| Load transfer to pile P2 | | | | | P+ PMx+ PMy of P2 | | 3,000.00 | kN | P2 | 1165.89 | -68.26 | 5.16 | | | | |
| Load transfer to pile P3 | | | | | P+ PMx+ PMy of P3 | | 3,000.00 | kN | P3 | 1165.89 | -68.26 | -5.16 | | | | |
| Load transfer to pile P4 | | | | | P+ PMx+ PMy of P4 | | 3,000.00 | kN | P4 | 1165.89 | 178.70 | 3.19 | | | | |
| Load transfer to pile P5 | | | | | P+ PMx+ PMy of P5 | | 3,000.00 | kN | P5 | 1165.89 | 178.70 | -3.19 | | | | |
| Section location from column center | | | | | | | 1,257.5 | mm | | | | | | | | |
| Pile No | Load (kN) | | Covered(mm) | % covered | Shear(kN) | | | | | P, PMx and PMy - refer in "Check for Maximum load on Pile" part | | | | | | |
| P1 | 3,000.00 | 2 | 282 | 46.92 | 1592.38 | | | | | | | | | | | |
| P2 | 3,000.00 | 1 | 0 | 0.00 | 0.00 | | | | | | | | | | | |
| P3 | 3,000.00 | 1 | 0 | 0.00 | 0.00 | | | | | | | | | | | |
| P4 | 3,000.00 | 2 | 525 | 87.54 | 373.93 | | | | | | | | | | | |
| P5 | 3,000.00 | 2 | 525 | 87.54 | 373.93 | | | | | | | | | | | |
| * Covered & % Covered calculation- Refer 4piles validation sheet | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| Design Shear Force | | | | | | Vu | 1592.38 | kN | | | | | | | | |
| Effective depth of pilecap | | | | | Depth- Cover- 20/2 | Deff | 1,815 | mm | | | | | | | | |
| shear due to P1+P2+P3 | | | | | | | 1,592 | kN | | | | | | | | |
| Slope for edge P1+P2+P3 | | | | | (Pb/2 + Cpc)/(Rpc+Bpc-Dpc) | | 1.376 | | | | | | | | | |
| Effective width of pile cap for P1+P2+P3 | | | | | | Beff1 | 1,582.03 | mm | | | | | | | | |
| shear due to P4+P5 | | | | | | | 747.86 | kN | | | | | | | | |
| Effective width of pile cap | | | | | (Cpc/Dpc)*(Bpc-Sectn location from colmn centre)*2+ Pb | Beff2 | 2,300 | mm | | | | | | | | |
| Reinforcement required | | | | | Ast req/ (1000*Deff) | pt | 0.0026 | ratio | | | | | | | | |
| | | | | | | Vu*d/Mu | 1.00 | | | | | | | | | |
| | | | | | | ϕVc1 | 1,634.66 | kN | clause 11.2.2.1 | | | | | | | |
| | | | | | | ϕVc2 | 2,376.47 | | | | | | | | | |
| Check | | | | | (shear due to P1+P2+P3) < ϕVc1 & (shear due to P4+P5) < ϕVc2 | | OK | | | | | | | | | |
| | | | | | (shear due to P1+P2+P3 - ϕVc1)/ ϕ | Vs1 | - | | | | | | | | | |
| | | | | | (shear due to P4+P5 - ϕVc2)/ ϕ | Vs2 | - | | | | | | | | | |
| | | | | | Max ( Vs1, Vs2) | Vs | - | kN | | | | | | | | |
| | | | | | | Vs perm | - | kN | clause 11.4.7.9 | | | | | | | |
| Check | | | | | Vs > Vs perm | | - | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Shear Reinforcement Calculations** | | | | | | | | | | | | | | | | |
| Area of shear reinforcement required | | | | | (Vs*1000/(Deff*fyt))*1000 | Asv req | - | Sqmm | | | | | | | | |
| Provided Shear reinforcement | | | | | | Asv prv | - | Sqmm | | | | | | | | |
| Shear capacity by Shear reinforcment | | | | | Asv prv* Deff* fyt | Vscap | - | kN | | | | | | | | |
| Check | | | | | [ϕ * (Vc + Vs)] > Vu | | - | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Step 10)Design of Face reinforcement** | | | | | | | | | | | | | | | | |
| Beff considered for SFR | | | | | | Beff SFR | 500 | mm | | | | | | | | |
| Area of side face reinf. Required | | | | | SFR% x D x Beff sfr | Asfr Req | 468.75 | Sqmm | | | | | | | | |
| Area of side face reinf. Provided | | | | | | Asfr pro | 425 | Sqmm | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Step 11)Design For Column Load Transfer** | | | | | | | | | | | | | | | | |
| Area of pilecap base | | | | | Area of Pilecap | A1 | 7.98 | 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 | | | | | $\Phi_1$ x 0.85 x Modification Factor x A2 x Fck x 1000 | $\Phi_1$Pnb | 10829 | kN | *Clause 10.14* | | | | | | | |
| Check | | | | | $\Phi_1$Pnb > Pu | | SAFE | | | | | | | | | |
| Area Of Dowels | | | | | | | - | sqmm | | | | | | | | |

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

$= 0.29\lambda\sqrt{f'_c}\, b_w d$

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

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

**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.