Print Calculation Sheet

Pile Cap 1

(IS-456:2000, Including Amendment 1)

PILE ARRANGEMENT

Column Dimensions

Column Shape : Rectangular

Column Length - X (Pl) : 0.250 m

Column Width - Z (Pw) : 0.250 m

Pedestal

Include Pedestal : No

Pedestal Shape : N/A

Pile Cap Geometrical Data

Pile Cap Length P_{CL} : 1.739 m

Pile Cap Width P_{CW} : 1.900 m

Initial Pile Cap Thickness t_I : 0.780 m

Pile Geometrical Data

Pile spacing P_s : 1.200 m

Pile Edge distance **e** : 0.350 m

Pile Diameter d_p : 0.400 m

Pile Capacities

Axial Capacity P_P : 250.000 kN

Lateral Capacity P_L : 100.000 kN

Uplift Capacity P_U : 80.000 kN

Material Properties

Concrete f_{ck} : 25000.004 kN/m^2

Reinforcement f_y : 415000.070 kN/m^2

Concrete Cover

Bottom Clear Cover CC_B : 0.050 m

Side Clear Cover CC_S : 0.050 m

Pile in Pile Cap PC_P : 0.050 m

Loading applied at top of cap

For the loads shown in this table, the sign convention is the same as that for JOINT LOADS in STAAD.Pro when global Y is the vertical axis.

Applied Loads - Service Stress Level						
Load Case	F_x (kN)	F_y (kN) **Downwards is negative Upwards is positive**	F_z (kN)	M_x (kNm)	M_z (kNm)	**Code**
101	0.000	-500.000	0.000	0.000	0.000	-

Applied Loads - Strength Level						
Load Case	F_x (kN)	F_y (kN) **Downwards is negative Upwards is positive**	F_z (kN)	M_x (kNm)	M_z (kNm)	**Code**
102	0.000	-750.000	0.000	0.000	0.000	-

Pile Cap size (in investigated direction) **H** : 1.739 m

Pile Cap size (in investigated perpendicular direction) **B** : 1.900 m

PILE CAP DESIGN CALCULATION

Calculation is performed with 0.780 m, but the required final depth is 1.106 m. Please redesign with 1.106 m.

Self Weight Calculation

Self Weight : 73.709 kN

Pedestal Weight : 0.000 kN

Soil Weight : 0.000 kN

Extra weight for Surcharge : 0.000 kN

Buoyancy Reduction : 0.000 kN

Maximum Pile Reactions For Service Load Cases

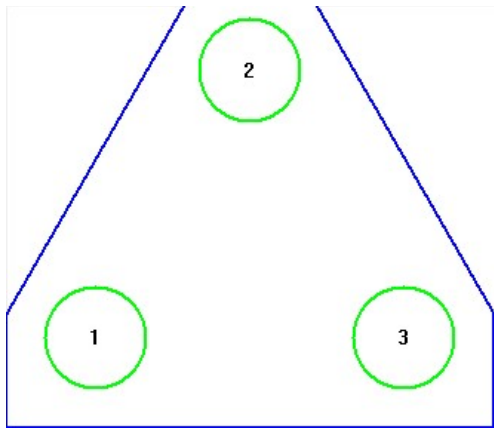
Reaction Type	Load case No.	Pile No.	X Coord. (m)	Z Coord. (m)	Reaction (kN)	Allowable (kN)	Capacity Chk
Axial	101	2	0.000	-0.693	-191.247	250.000	Pass
Lateral	N/A	N/A	N/A	N/A	0.000	100.000	Pass
Uplift	N/A	N/A	N/A	N/A	0.000	80.000	Pass

Maximum Pile Reactions For Ultimate Load Cases

Total number of piles **N** = 3

Critical Load Case = 102

This is the load case for which the pilecap depth required is the maximum. If there are multiple load cases for which the same maximum depth is required, then the load case with the highest axial load (absolute value) is considered as the critical load case.



	Arrangement		Reaction		
Pile No.	X (m)	Z (m)	Axial (kN)	Lateral (kN)	Uplift (kN)
1	-0.600	0.346	-274.562	0.000	0.000
2	0.000	-0.693	-274.585	0.000	0.000
3	0.600	0.346	-274.562	0.000	0.000

Pile Cap Thickness Check

Calculated Thickness (t) : 1.106 m

Check for Moment (Along Base Beam)

Hence Governing moment (M_u)after deducting the moments due to selfweight and surcharge = = 130.414 kNm

We assume singly reinforced and under reinforced section

Effective Depth(d) = $h_{cap} - (P_{id} + cc + 1.5 \times d_b)$ = 0.988 m

Depth of neutral axis for balanced section(x_u) = $\frac{700 \times d}{1100 + 0.87 f_y}$ = 0.473 m

As Per IS 456 2000 ANNEX G,G-1.1 C

Ultimate moment of resistance (M_{ulim}) = $0.36 \times f_{ck} \times b \times X_u \times (d - 0.416 \times X_u)$ = 2359.091 kNm

We observed M_u <= M_{ulim} hence singly reinforced and under reinforced section can be used.

Check for Moment (Along Alternate Beam)

Hence Governing moment (M_u)after deducting the moments due to selfweight and surcharge = 121.579 kNm

We assume singly reinforced and under reinforced section

Effective Depth(d) = $h_{cap} - (P_{id} + cc + 1.5 \times d_b)$ = 0.988 m

Depth of neutral axis for balanced section(x_u) = $\frac{700 \times d}{1100 + 0.87 f_y}$ = 0.473 m

As Per IS 456 2000 ANNEX G,G-1.1 C

Ultimate moment of resistance (M_{ulim}) = $0.36 \times f_{ck} \times b \times X_u \times (d - 0.416 \times X_u)$ = 2359.091 kNm

We observed M_u <= M_{ulim} hence singly reinforced and under reinforced section can be used.

Check for One Way Shear (Along Base Beam) As per Clause No. 34.2.4.1(a), Amendment 1, shear at deff/2 distance from column face

Critical Load Case = 102

Design Shear force (V_u)	=		=	200.318	kN

As Per IS 456 2000 ANNEX B,B-5.1

Design Shear Stress (T_v)	=	$\frac{V_u}{B \times d}$	=	289.644	kN/m^2
Allowable Shear Stress (T_c)	=	min (SEF x Tc1, Tc max)	=	918.328	kN/m^2
Where, T_{c1}	=	$\frac{0.85 \times \sqrt{0.8 \times f_{ck}}}{6 \times \beta} \times \left(\sqrt{1 + 5 \times \beta} - 1\right)$	=	918.328	kN/m^2
$T_{c\ max}$ as per Table 20	=	3100.000	kN/m^2		
Shear Enhancement Factor(SEF) as per IS 456 2000 Clause 40.5.1, Fig 24	=	1.000			

T_c is calculated on the basis of SP16 Eqn at clause- 4.1.

Note- If the shear enhancement Factor is not considered from Global Setting option, then this SEF would be considered as 1

Where Beta	=	$max\left[\frac{0.8 \times f_{ck}}{6.89 \times p_t}, 1\right]$	=	1.000
and percentage of steel required (p_t)	=	$\frac{100\ A_{st}}{B \times d}$	=	48.470

Here T_v <= T_c Hence, safe.

Check for One Way Shear (Along Alternate Beam) As per Clause No. 34.2.4.1(a), Amendment 1, shear at deff/2 distance from column face

Critical Load Case = 102

Design Shear force (V_u)	=		=	-184.400	kN

As Per IS 456 2000 ANNEX B,B-5.1

Design Shear Stress (T_v)	=	$\frac{V_u}{B \times d}$	=	174.524	kN/m^2
Allowable Shear Stress (T_c)	=	min (SEF x Tc1, Tc max)	=	918.328	kN/m^2
Where T_{c1}	=	$\frac{0.85 \times \sqrt{0.8 \times f_{ck}}}{6 \times \beta} \times \left(\sqrt{1 + 5 \times \beta} - 1\right)$	=	918.328	kN/m^2
$T_{c\ max}$ As per Table 20	=	3100.000	kN/m^2		
Shear Enhancement Factor(SEF) as per IS 456 2000 Clause 40.5.1, Fig 24	=	1.000			

T_c is calculated on the basis of SP16 Eqn at clause- 4.1.

Note- If the shear enhancement Factor is not considered from Global Setting option, then this SEF would be considered as 1

Where Beta	=	$max\left[\frac{0.8 \times f_{ck}}{6.89 \times p_t}, 1\right]$	=	1.000
and percentage of steel required (p_t)	=	$\frac{100\ A_{st}}{B \times d}$	=	129.254

Here T_v <= T_c Hence, safe.

Punching Shear Check for Corner Piles

Pile No.	Shear Force (kN)
1	-274.562
2	-274.585
3	-274.562

Governing reaction (P_{Cr}) = maximum of (P_i, P_j,... P_n) = 274.585kN

Pile Edge distance (P_e) = 0.350m

$d_{critical}$ = $\frac{P_{cr}}{min[\{T_{c\ punch}\theta.(P_d + d) + 2p_e\}, \{T_{c\ shear}.\ length\ of\ Shear\ line\}]}$ = 0.301m

$d >= d_{critical}$. Hence, safe.

Calculation of Maximum Bar Size

Selected maximum bar size	=	Ø16	
Bar diameter corresponding to max bar size (d_b)	=	16	mm

As Per IS 456 2000 Clause No 26.2.1

Development Length (l_d) = $\frac{0.87 \times d_b \times f_y}{4 \times \tau_{bd}}$	=	0.645	m
Available Development Length (l_{db}) (for Base beam)	=	18.980	m
Available Development Length (l_{db}) (for Alternate beam)	=	= 18.819	m

l_{db}(Base) >l_d. Hence, safe.

l_{db}(Alt.) >l_d. Hence, safe.

Selection of Reinforcement

Along Base Beam

Critical Load Case : 102

As Per IS 456 2000 Clause 26.5.2.1

Note - "Area of Steel required" reported here is the larger value between the calculated area of steel and minimum steel required as per code stipulation

Minimum Area of Steel (A_{stmin})	=		=	892.080 mm2

As Per IS 456 2000 ANNEX G,G-1.1 b

Area of steel required (A_{sq})	=	$0.5 \times \left(\frac{f_{ck}}{f_y}\right) \times \left(1 - \sqrt{1 - \frac{4.5977 \times M_u}{f_{ck} \times b \times d^2}}\right) \times b \times d$	=	0.000 mm2
Area of steel provided (A_{st})	=		=	892.080 mm2

A_{stmin}<= A_{st}. Steel area is accepted

Minimum spacing allowed (S_{min}) = 40 + d_b	=	52	mm
Selected Bar Size	=	12 mm	
Selected spacing (S)	=	450.00	mm

S_{min}<= S <= 450 mm and selected bar size < selected maximum bar size. The reinforcement is accepted.

Along Alternate Beam

Critical Load Case : 102

As Per IS 456 2000 Clause 26.5.2.1

Note - "Area of Steel required" reported here is the larger value between the calculated area of steel and minimum steel required as per code stipulation

Minimum Area of Steel (A_{stmin}) = 955.080 mm2

As Per IS 456 2000 ANNEX G,G-1.1 b

Area of steel required (A_{sq}) = $0.5 \times \left(\frac{f_{ck}}{f_y}\right) \times \left(1 - \sqrt{1 - \frac{4.5977 \times M_u}{f_{ck} \times b \times d^2}}\right) \times b \times d$ = 0.000 mm2

Area of steel provided (A_{st}) = 955.080 mm2

A_{stmin}<= A_{st} Steel area is accepted

Minimum spacing allowed (S_{min}) = 40 + d_b	=	52.00	mm
Selected Bar Size	=	12 mm	
Selected spacing (S)	=	95.00	mm

S_{min}<= S <= 450 mm and selected bar size < selected maximum bar size. The reinforcement is accepted.