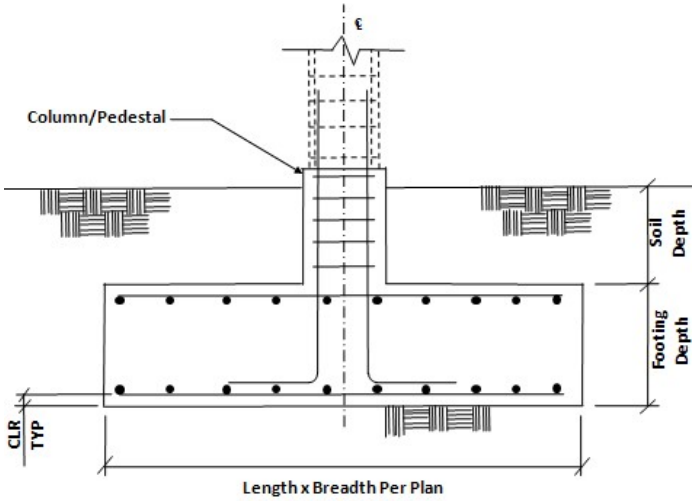
Isolated Footing Design (IS 456-2000)

Footing No.	Group ID	Foundation Geometry		
-	-	Length	Width	Thickness
32	1	3.500 m	3.500 m	0.406 m
33	2	1.900 m	1.900 m	0.305 m
34	3	1.900 m	1.900 m	0.305 m
35	4	3.500 m	3.500 m	0.406 m
36	5	1.950 m	1.950 m	0.305 m
37	6	2.350 m	2.350 m	0.305 m
38	7	2.350 m	2.350 m	0.305 m
39	8	1.800 m	1.800 m	0.305 m
40	9	1.950 m	1.950 m	0.305 m
41	10	2.350 m	2.350 m	0.305 m
42	11	2.350 m	2.350 m	0.305 m
43	12	1.800 m	1.800 m	0.305 m
44	13	3.500 m	3.500 m	0.406 m
45	14	1.900 m	1.900 m	0.305 m
46	15	1.900 m	1.900 m	0.305 m
47	16	3.500 m	3.500 m	0.406 m
173	17	1.300 m	1.300 m	0.305 m
174	18	1.300 m	1.300 m	0.305 m

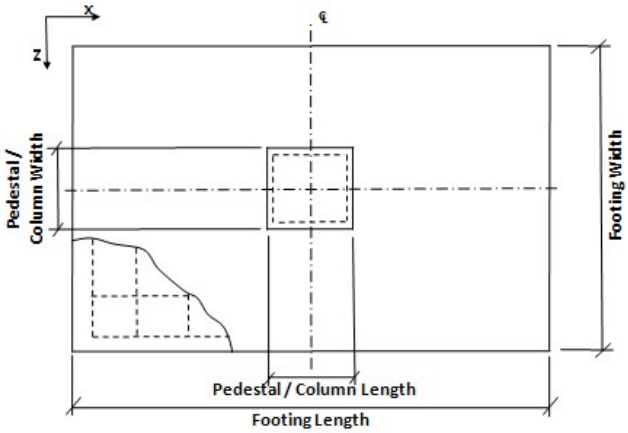
Footing No.	Footing Reinforcement				Pedestal Reinforcement	
-	Bottom Reinforcement(M_z)	Bottom Reinforcement(M_x)	Top Reinforcement(M_z)	Top Reinforcement(M_x)	Main Steel	Trans Steel
32	Ø8 @ 50 mm c/c	Ø8 @ 55 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A

33	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
34	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
35	Ø8 @ 50 mm c/c	Ø8 @ 55 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
36	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
37	Ø6 @ 50 mm c/c	Ø6 @ 60 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
38	Ø6 @ 50 mm c/c	Ø6 @ 60 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
39	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
40	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
41	Ø6 @ 50 mm c/c	Ø6 @ 60 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
42	Ø6 @ 50 mm c/c	Ø6 @ 60 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
43	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
44	Ø8 @ 50 mm c/c	Ø8 @ 55 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
45	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
46	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
47	Ø8 @ 50 mm c/c	Ø8 @ 55 mm c/c	Ø6 @ 75 mm c/c	Ø6 @ 75 mm c/c	N/A	N/A
173	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A
174	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	Ø6 @ 70 mm c/c	N/A	N/A

Isolated Footing 32



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction : 0.500
Factor of Safety Against Sliding : 1.500
Factor of Safety Against Overturning : 1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z
Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1124.187	-1.923	-0.953	-0.914	1.963
2	141.831	-5.712	-3.134	-3.022	5.874
4	35.458	-1.428	-0.784	-0.756	1.468
5	0.011	-0.021	0.019	0.016	0.028
6	0.016	-0.001	-0.025	-0.022	0.015

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1124.187	-1.923	-0.953	-0.914	1.963
2	141.831	-5.712	-3.134	-3.022	5.874
4	35.458	-1.428	-0.784	-0.756	1.468
5	0.011	-0.021	0.019	0.016	0.028
6	0.016	-0.001	-0.025	-0.022	0.015

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m
Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN
Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

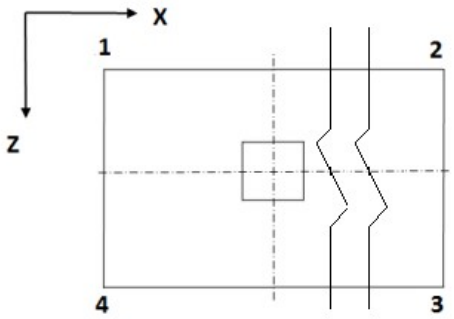
Min. area required from bearing pressure, A_{min} = P / q_{max} = 11.318 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

Length (L_2) =	3.500	m	Governing Load Case :	# 1
Width (W_2) =	3.500	m	Governing Load Case :	# 1
Depth (D_2) =	0.406	m	Governing Load Case :	# 1
Area (A_2) =	12.250	m^2		

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
1	**99.9207**	99.2072	98.8701	99.5836	0.000
1	99.9207	**99.2072**	98.8701	99.5836	0.000
1	99.9207	99.2072	**98.8701**	99.5836	0.000
1	99.9207	99.2072	98.8701	**99.5836**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1)	Pressure at corner 2 (q_2)	Pressure at corner 3 (q_3)	Pressure at corner 4 (q_4)

	(kN/m2)	(kN/m2)	(kN/m2)	(kN/m2)
1	**99.9207**	99.2072	98.8701	99.5836
1	99.9207	**99.2072**	98.8701	99.5836
1	99.9207	99.2072	**98.8701**	99.5836
1	99.9207	99.2072	98.8701	**99.5836**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	316.553	639.096	1769.158	835.861
2	20.591	37.526	103.483	54.054
4	45.120	82.227	226.754	118.444
5	2272.599	2417.636	7333.729	4779.761
6	43250.878	1904.937	5609.499	10818.874

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -5.712 kN

Governing Restoring Force : 117.619 kN

Minimum Sliding Ratio for the Critical Load Case : 20.591

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -3.978 kNm

Governing Resisting Moment : 411.657 kNm

Minimum Overturning Ratio for the Critical Load Case : 103.483

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -3.134 kN

Governing Restoring Force : 117.619 kN

Minimum Sliding Ratio for the Critical Load Case : 37.526

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 7.616 kNm

Governing Resisting Moment : 411.657 kNm

Minimum Overturning Ratio for the Critical Load Case : 54.054

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 373.971 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 399.460 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

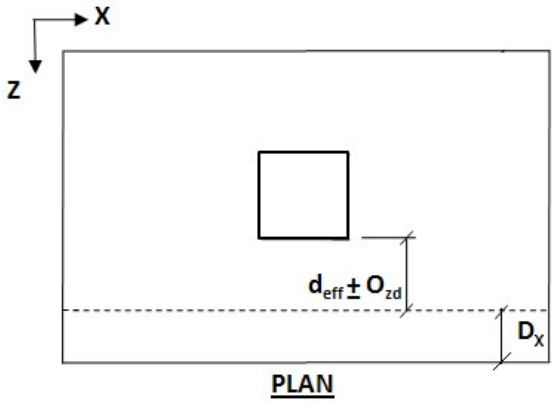
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #1

D_X = 0.352 m

Shear Force(S) = 377.223 kN

Shear Stress(T_v) = 306.187772 kN/m2

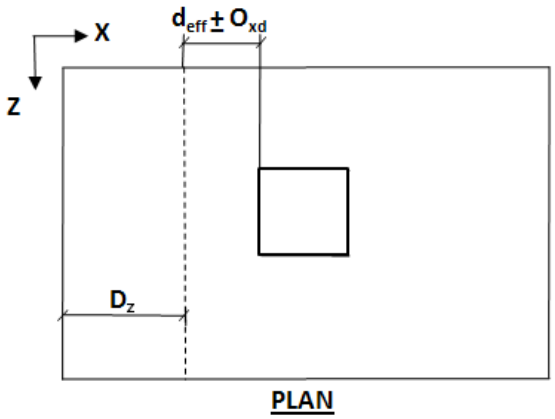
Percentage Of Steel(P_t) = 0.2670

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 375.288 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



Critical Load Case = #1

D_Z = 0.352 m

Shear Force(S) = 393.817 kN

Shear Stress(T_v) = 319.656277 kN/m2

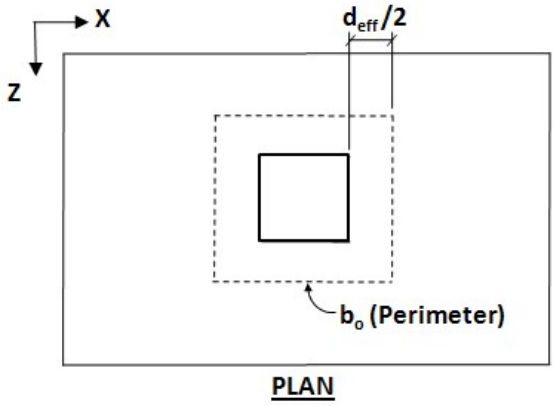
Percentage Of Steel(P_t) = 0.2492

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 364.214 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #1

Shear Force(S) = 1072.520 kN

Shear Stress(T_v) = 1012.943 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 1.525 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

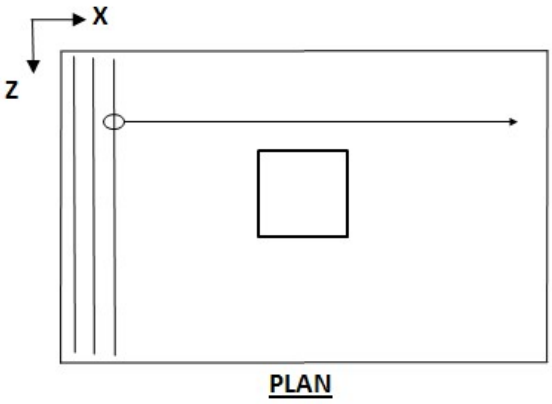
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \Gamma_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 1.475 m

l_{db} >=l_d hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3069.587 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3069.587 mm2

A_{stmin}<= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = 48.000 mm

Selected spacing (S) = 55.607 mm

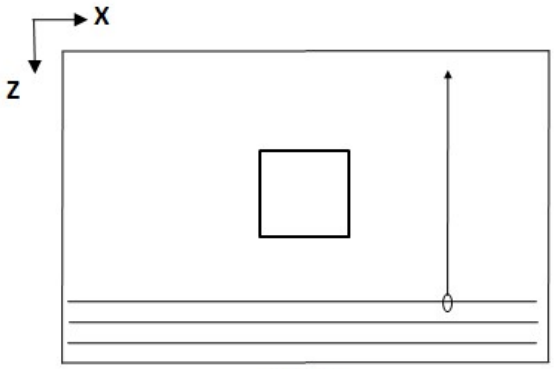
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 55.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3288.947 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3288.947 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 52.185 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

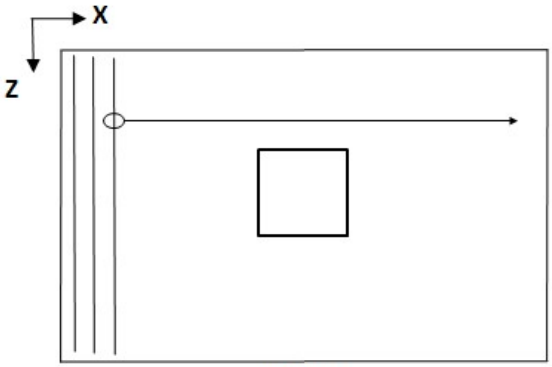
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 34.480 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 75.422 mm

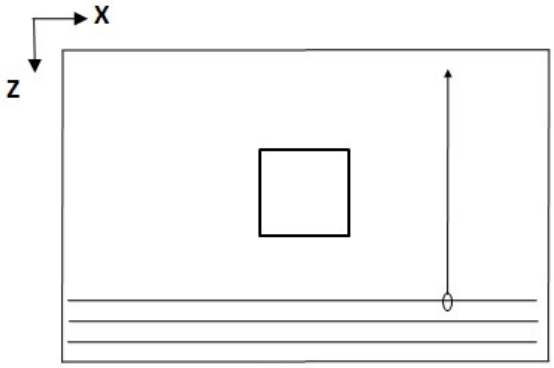
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 36.778 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 75.422 mm

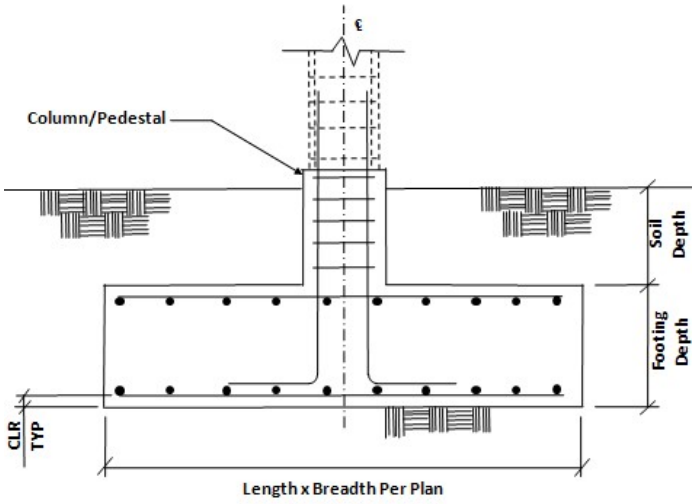
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

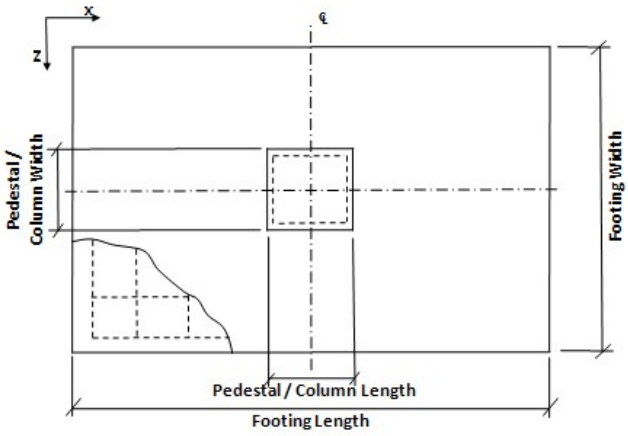
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Isolated Footing 33



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.114	0.550	-1.551	-1.528	-0.473
2	290.751	0.032	-6.770	-6.676	0.226
4	72.688	0.008	-1.692	-1.669	0.056
5	0.005	-0.011	0.000	0.000	0.019
6	-0.020	-0.008	-0.077	-0.067	0.021

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.114	0.550	-1.551	-1.528	-0.473
2	290.751	0.032	-6.770	-6.676	0.226
4	72.688	0.008	-1.692	-1.669	0.056
5	0.005	-0.011	0.000	0.000	0.019
6	-0.020	-0.008	-0.077	-0.067	0.021

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 2.984 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

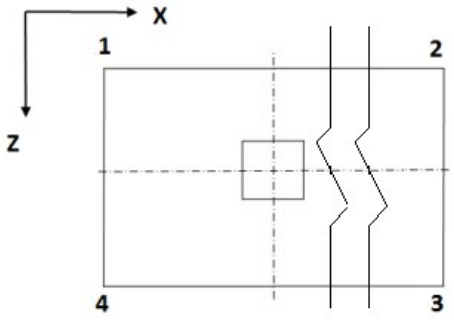
Length (L_2) = 1.900 m Governing Load Case : # 2

Width (W_2) = 1.900 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.610 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**96.0005**	95.6224	80.3304	80.7086	0.000
2	96.0005	**95.6224**	80.3304	80.7086	0.000
2	96.0005	95.6224	**80.3304**	80.7086	0.000
2	96.0005	95.6224	80.3304	**80.7086**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**96.0005**	95.6224	80.3304	80.7086
2	96.0005	**95.6224**	80.3304	80.7086
2	96.0005	95.6224	**80.3304**	80.7086
2	96.0005	95.6224	80.3304	**80.7086**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	185.211	65.647	96.663	302.094
2	5040.980	23.508	34.593	1398.837
4	6349.090	29.607	43.568	1761.787
5	1248.120	60641.051	86824.191	1152.950
6	1628.733	178.247	287.499	1094.508

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 1
Governing Disturbing Force : 0.550 kN
Governing Restoring Force : 101.820 kN
Minimum Sliding Ratio for the Critical Load Case : 185.211
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : -8.740 kNm
Governing Resisting Moment : 302.358 kNm
Minimum Overturning Ratio for the Critical Load Case : 34.593

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : -6.770 kN
Governing Restoring Force : 159.139 kN
Minimum Sliding Ratio for the Critical Load Case : 23.508
Critical Load Case for Overturning about Z-Direction : 1
Governing Overturning Moment : -0.640 kNm
Governing Resisting Moment : 193.455 kNm
Minimum Overturning Ratio for the Critical Load Case : 302.094

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 43.063 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 46.034 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

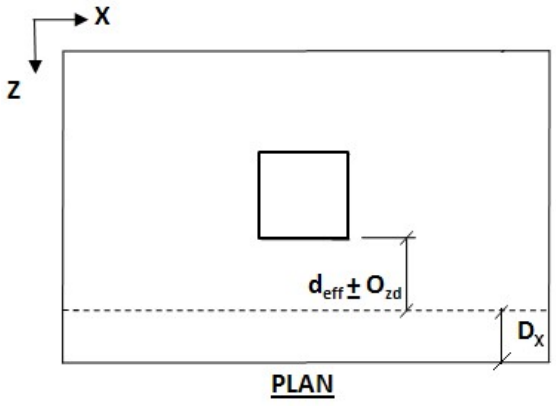
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 77.543 kN

Shear Stress(T_v) = 161.951830 kN/m2

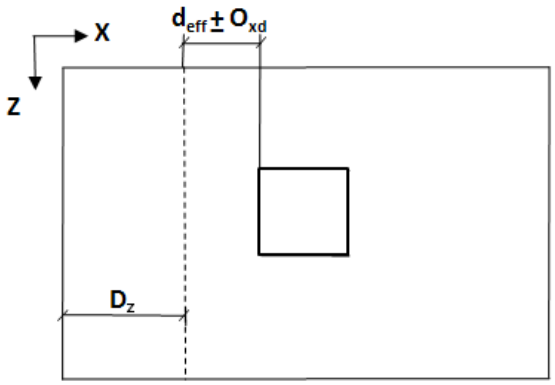
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 80.169 kN

Shear Stress(T_v) = 167.437865 kN/m2

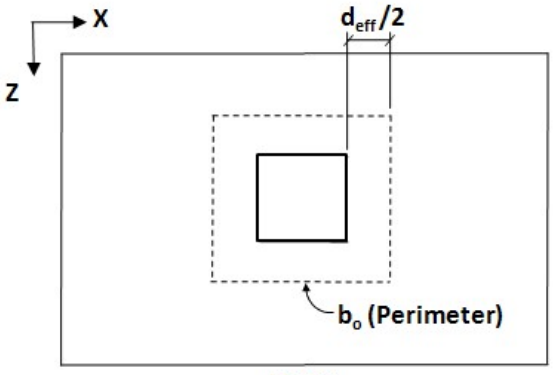
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 256.714 kN

Shear Stress(T_v) = 390.609 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.725 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

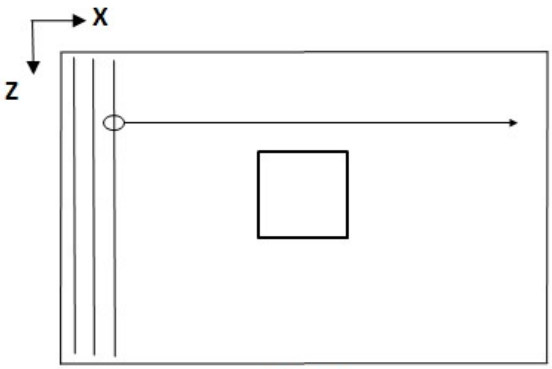
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.675 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 481.336 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 74.750 mm

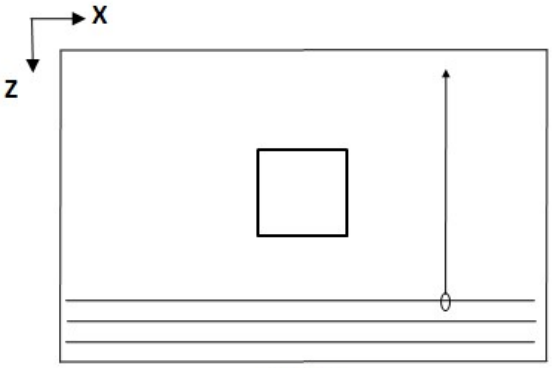
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 515.159 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

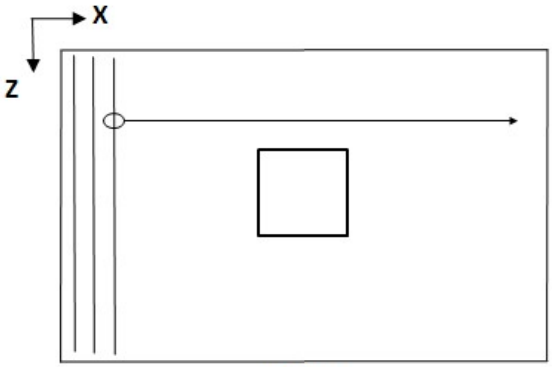
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.230 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.750 mm

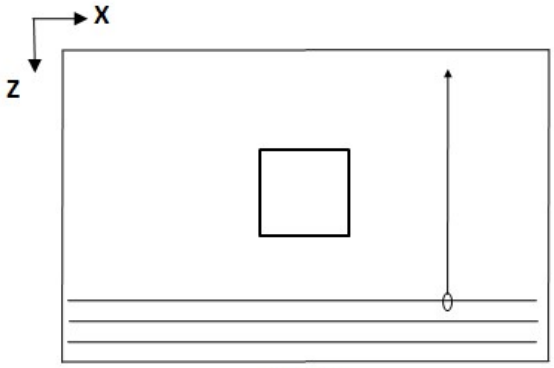
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.834 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

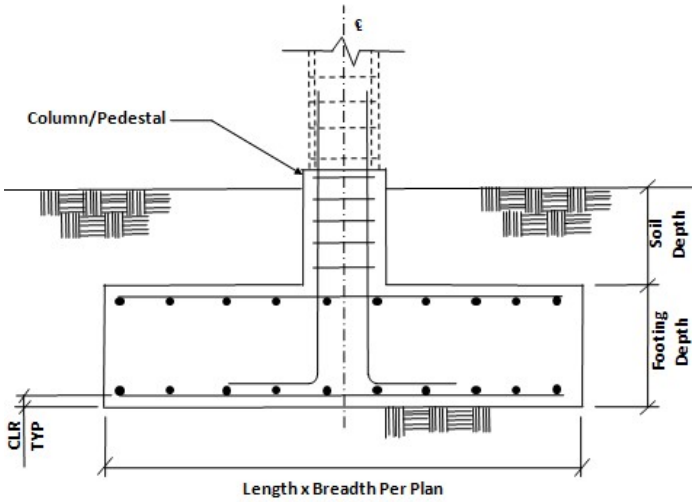
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

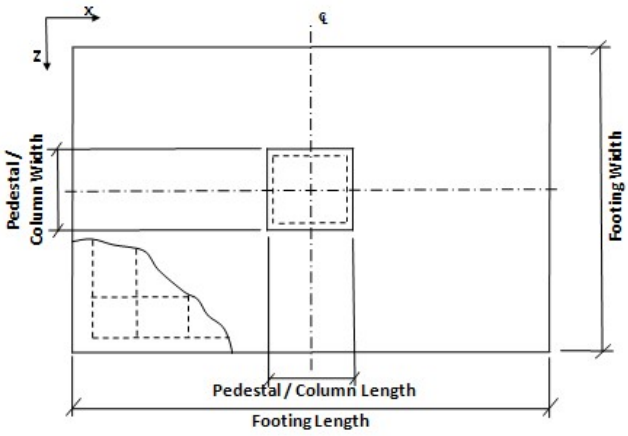
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 34



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.174	-0.668	-1.551	-1.528	0.729
2	290.811	-0.461	-6.770	-6.676	0.699
4	72.703	-0.115	-1.693	-1.669	0.175
5	0.004	-0.003	0.000	0.000	0.013
6	-0.021	-0.014	-0.077	-0.067	0.026

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.174	-0.668	-1.551	-1.528	0.729
2	290.811	-0.461	-6.770	-6.676	0.699
4	72.703	-0.115	-1.693	-1.669	0.175
5	0.004	-0.003	0.000	0.000	0.013
6	-0.021	-0.014	-0.077	-0.067	0.026

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 2.984 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

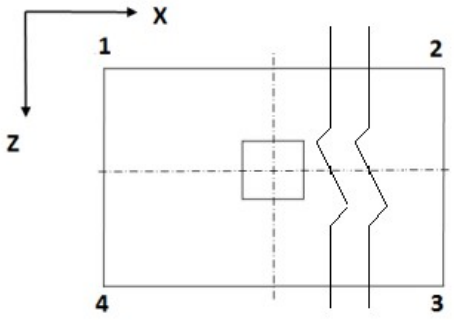
Length (L_2) = 1.900 m Governing Load Case : # 2

Width (W_2) = 1.900 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.610 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**96.5633**	95.0945	79.8008	81.2696	0.000
2	96.5633	**95.0945**	79.8008	81.2696	0.000
2	96.5633	95.0945	**79.8008**	81.2696	0.000
2	96.5633	95.0945	79.8008	**81.2696**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**96.5633**	95.0945	79.8008	81.2696
2	96.5633	**95.0945**	79.8008	81.2696
2	96.5633	95.0945	**79.8008**	81.2696
2	96.5633	95.0945	79.8008	**81.2696**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	152.361	65.688	96.726	207.481
2	345.205	23.509	34.596	360.226
4	434.754	29.608	43.570	453.670
5	4045.039	72448.775	109913.878	1888.797
6	966.397	178.314	288.935	858.576

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 1
Governing Disturbing Force : -0.668 kN
Governing Restoring Force : 101.850 kN
Minimum Sliding Ratio for the Critical Load Case : 152.361
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : -8.741 kNm
Governing Resisting Moment : 302.415 kNm
Minimum Overturning Ratio for the Critical Load Case : 34.596

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : -6.770 kN
Governing Restoring Force : 159.169 kN
Minimum Sliding Ratio for the Critical Load Case : 23.509
Critical Load Case for Overturning about Z-Direction : 1
Governing Overturning Moment : 0.933 kNm
Governing Resisting Moment : 193.512 kNm
Minimum Overturning Ratio for the Critical Load Case : 207.481

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 43.071 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 46.270 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

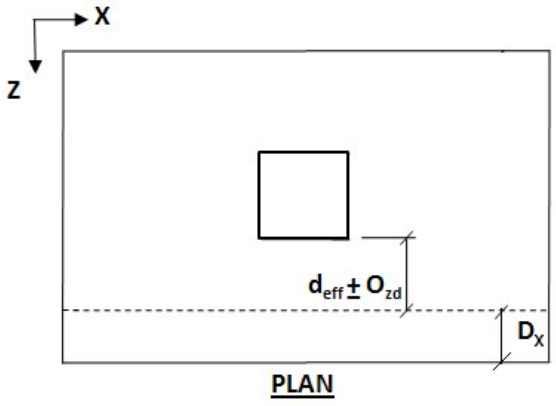
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 77.558 kN

Shear Stress(T_v) = 161.984191 kN/m2

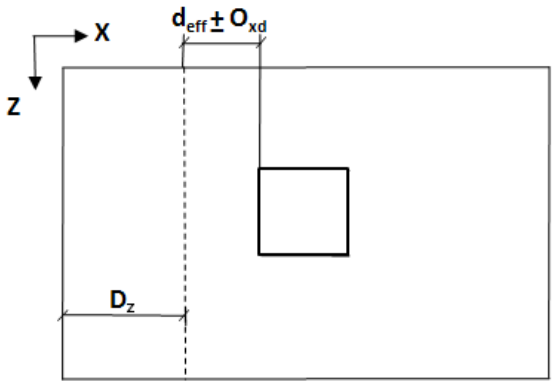
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 80.578 kN

Shear Stress(T_v) = 168.292492 kN/m2

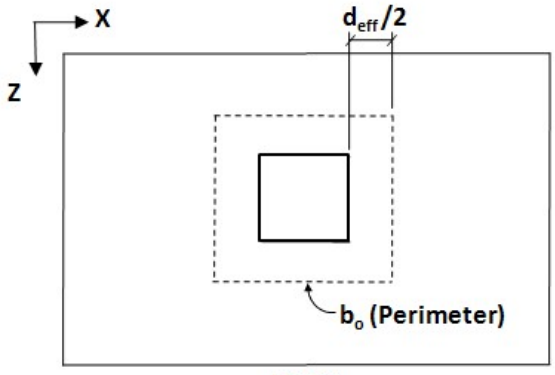
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 256.767 kN

Shear Stress(T_v) = 390.689 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.725 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

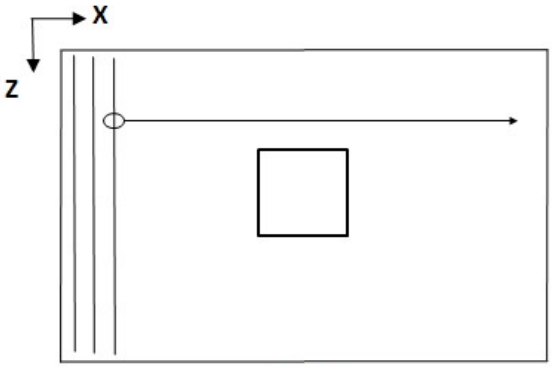
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.675 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 481.434 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 74.750 mm

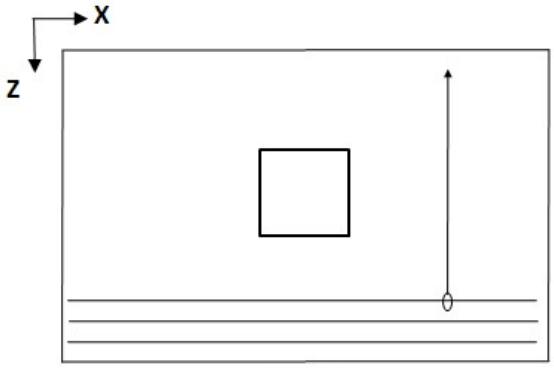
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 517.849 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

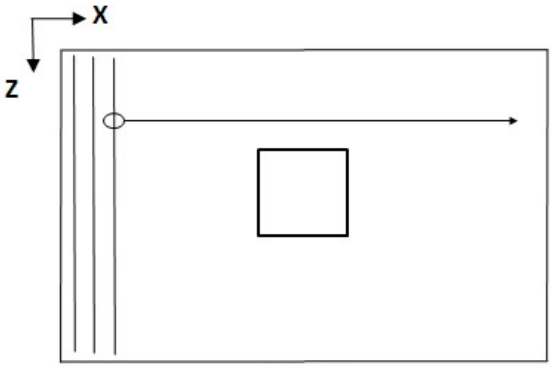
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.230 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.750 mm

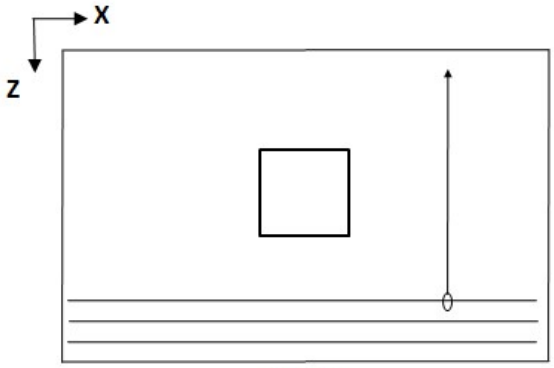
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.834 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

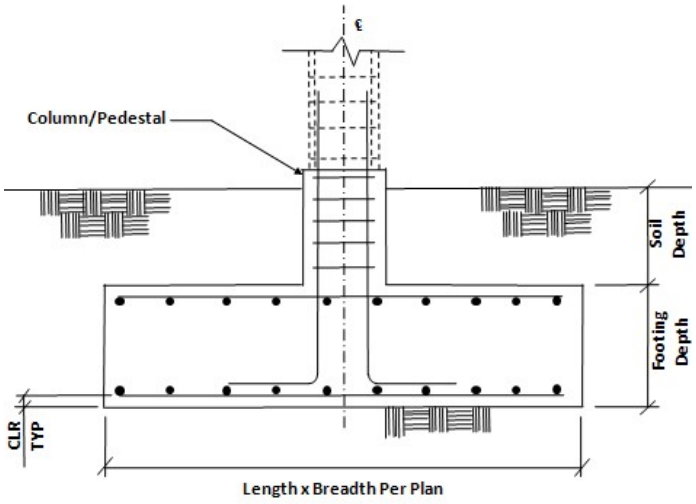
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

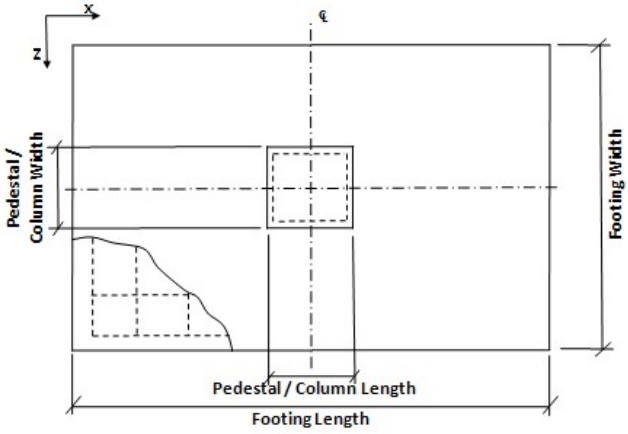
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 35



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1123.359	1.823	-0.899	-0.861	-1.725
2	140.963	5.327	-3.098	-2.984	-4.993
4	35.241	1.332	-0.774	-0.746	-1.248
5	-0.011	0.006	0.021	0.018	0.004
6	-0.017	-0.022	-0.022	-0.019	0.033

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1123.359	1.823	-0.899	-0.861	-1.725
2	140.963	5.327	-3.098	-2.984	-4.993
4	35.241	1.332	-0.774	-0.746	-1.248
5	-0.011	0.006	0.021	0.018	0.004
6	-0.017	-0.022	-0.022	-0.019	0.033

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 11.310 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

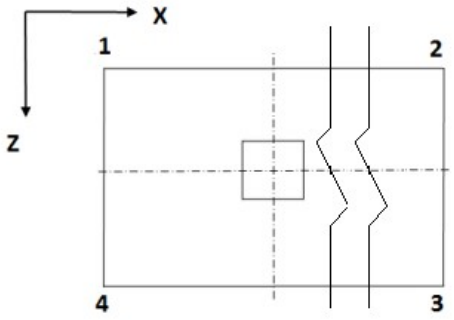
Length (L_2) = 3.500 m Governing Load Case : # 1

Width (W_2) = 3.500 m Governing Load Case : # 1

Depth (D_2) = 0.406 m Governing Load Case : # 1

Area (A_2) = 12.250 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
1	**99.1674**	99.8058	99.4881	98.8498	0.000
1	99.1674	**99.8058**	99.4881	98.8498	0.000
1	99.1674	99.8058	**99.4881**	98.8498	0.000
1	99.1674	99.8058	99.4881	**98.8498**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
1	**99.1674**	99.8058	99.4881	98.8498
1	99.1674	**99.8058**	99.4881	98.8498
1	99.1674	99.8058	**99.4881**	98.8498
1	99.1674	99.8058	99.4881	**98.8498**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	333.745	676.534	1876.224	933.629
2	21.998	37.831	104.388	61.977
4	48.299	83.063	229.196	136.078
5	7866.826	2207.605	6615.266	64031.297
6	2137.349	2150.242	6400.943	4125.248

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : 5.327 kN
Governing Restoring Force : 117.185 kN
Minimum Sliding Ratio for the Critical Load Case : 21.998
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : -3.929 kNm
Governing Resisting Moment : 410.139 kNm
Minimum Overturning Ratio for the Critical Load Case : 104.388

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : -3.098 kN
Governing Restoring Force : 117.185 kN
Minimum Sliding Ratio for the Critical Load Case : 37.831
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : -6.618 kNm
Governing Resisting Moment : 410.139 kNm
Minimum Overturning Ratio for the Critical Load Case : 61.977

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 373.668 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 399.053 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

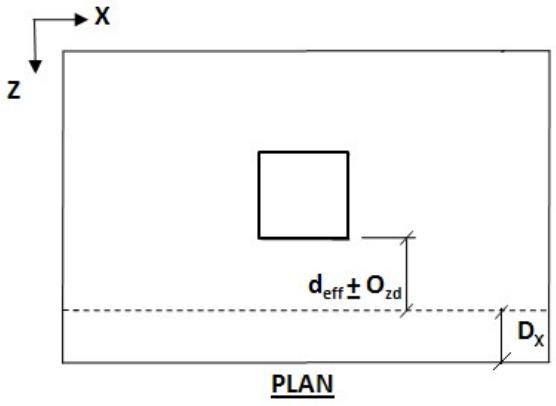
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #1

D_X = 0.352 m

Shear Force(S) = 376.919 kN

Shear Stress(T_v) = 305.940913 kN/m2

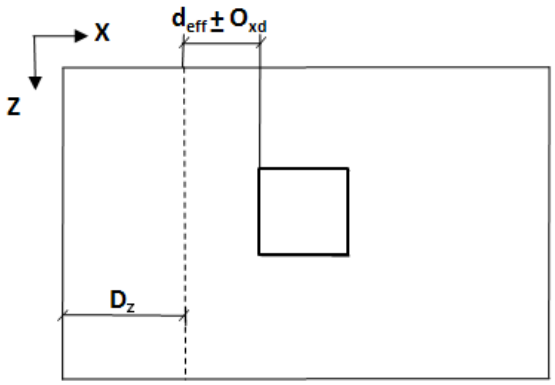
Percentage Of Steel(P_t) = 0.2667

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 375.114 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #1

D_Z = 0.352 m

Shear Force(S) = 393.422 kN

Shear Stress(T_v) = 319.336431 kN/m2

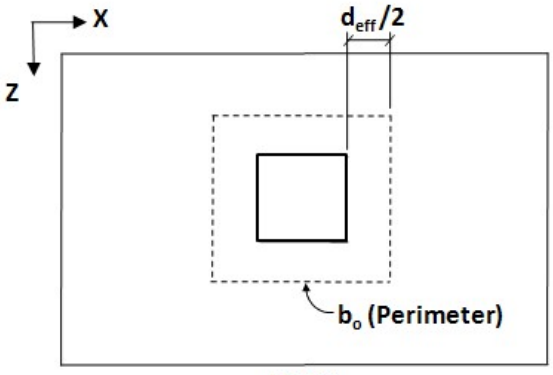
Percentage Of Steel(P_t) = 0.2489

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 364.079 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #1

Shear Force(S) = 1071.730 kN

Shear Stress(T_v) = 1012.196 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 1.525 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

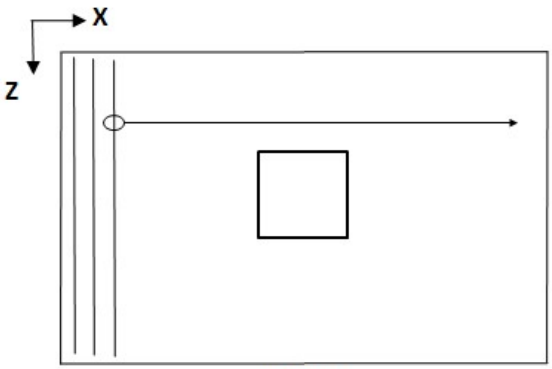
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 1.475 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3066.986 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3066.986 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = 48.000 mm

Selected spacing (S) = 55.607 mm

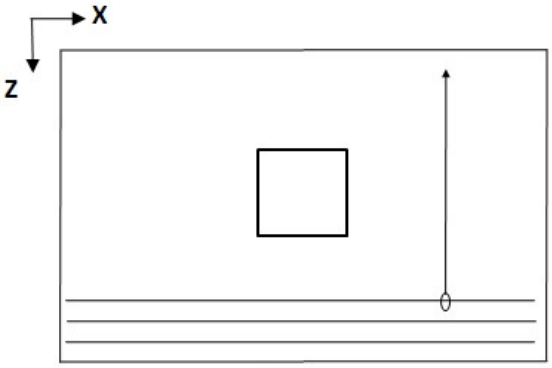
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 55.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3285.435 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3285.435 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 52.185 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

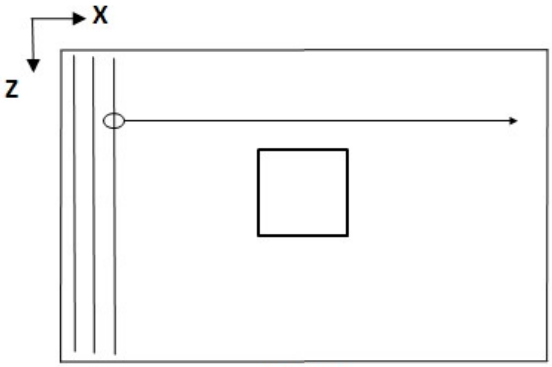
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 34.480 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 75.422 mm

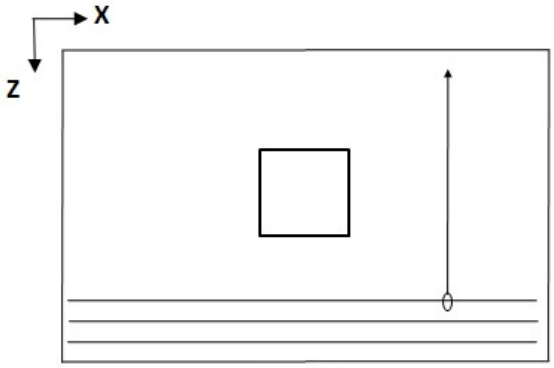
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 36.778 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 75.422 mm

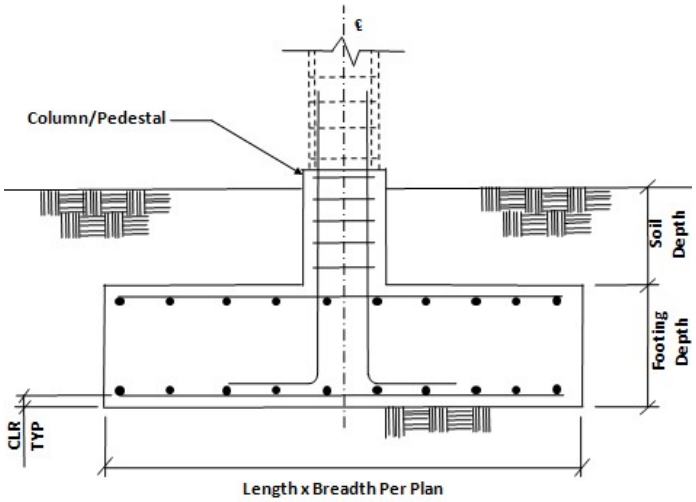
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

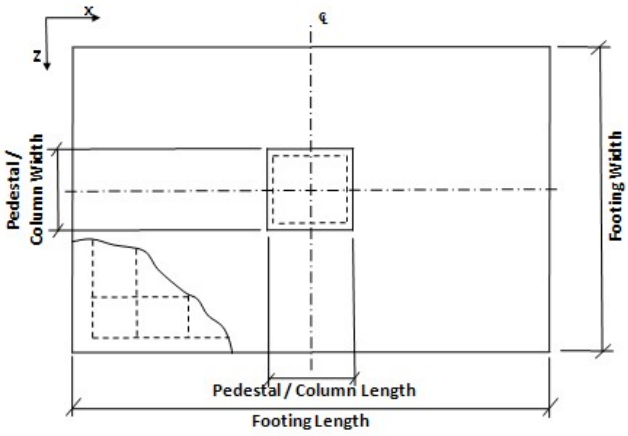
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Isolated Footing 36



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	227.514	-1.576	1.163	1.134	1.671
2	309.201	-7.012	0.302	0.297	7.345
4	77.300	-1.753	0.076	0.074	1.836
5	0.071	-0.021	0.002	0.001	0.016
6	0.022	0.010	-0.009	-0.008	-0.020

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	227.514	-1.576	1.163	1.134	1.671
2	309.201	-7.012	0.302	0.297	7.345
4	77.300	-1.753	0.076	0.074	1.836
5	0.071	-0.021	0.002	0.001	0.016
6	0.022	0.010	-0.009	-0.008	-0.020

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 3.168 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

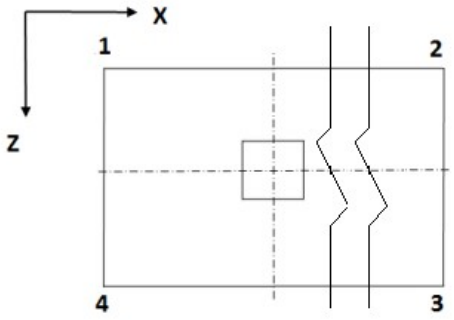
Length (L_2) = 1.950 m Governing Load Case : # 2

Width (W_2) = 1.950 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.803 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**96.2986**	80.9512	81.5819	96.9293	0.000
2	96.2986	**80.9512**	81.5819	96.9293	0.000
2	96.2986	80.9512	**81.5819**	96.9293	0.000
2	96.2986	80.9512	81.5819	**96.9293**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**96.2986**	80.9512	81.5819	96.9293
2	96.2986	**80.9512**	81.5819	96.9293
2	96.2986	80.9512	**81.5819**	96.9293
2	96.2986	80.9512	81.5819	**96.9293**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.803 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	81.356	110.319	167.995	116.208
2	24.116	559.135	846.150	34.771
4	30.319	702.940	1063.771	43.714
5	681.230	7889.618	20948.042	1249.912
6	1463.993	1664.736	2699.240	1245.170

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -7.012 kN
Governing Restoring Force : 169.098 kN
Minimum Sliding Ratio for the Critical Load Case : 24.116
Critical Load Case for Overturning about X-Direction : 1
Governing Overturning Moment : 1.489 kNm
Governing Resisting Moment : 250.091 kNm
Minimum Overturning Ratio for the Critical Load Case : 167.995

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 1
Governing Disturbing Force : 1.163 kN
Governing Restoring Force : 128.254 kN
Minimum Sliding Ratio for the Critical Load Case : 110.319
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 9.483 kNm
Governing Resisting Moment : 329.734 kNm
Minimum Overturning Ratio for the Critical Load Case : 34.771

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 44.724 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 426.508437 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 54.217 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

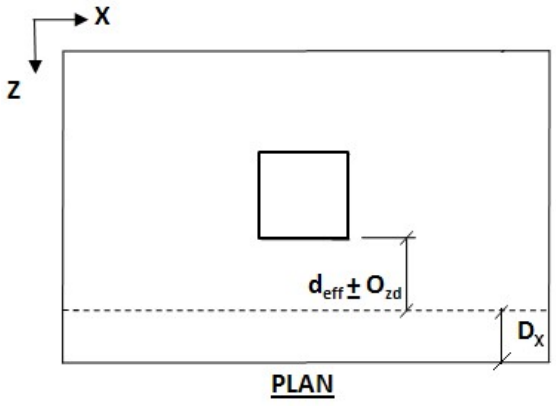
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 426.508437 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 79.193 kN

Shear Stress(T_v) = 161.158437 kN/m2

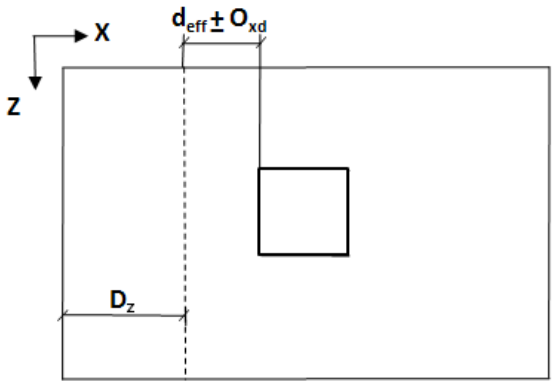
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 92.789 kN

Shear Stress(T_v) = 188.826070 kN/m2

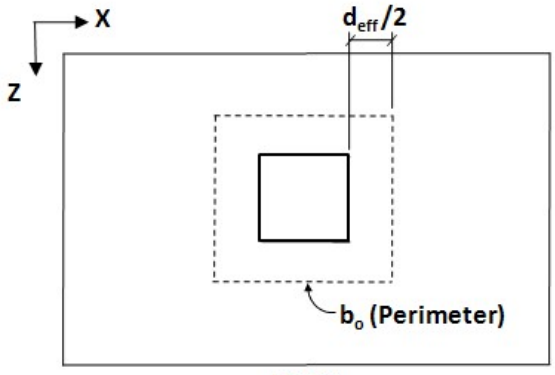
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 274.837 kN

Shear Stress(T_v) = 418.184 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.750 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

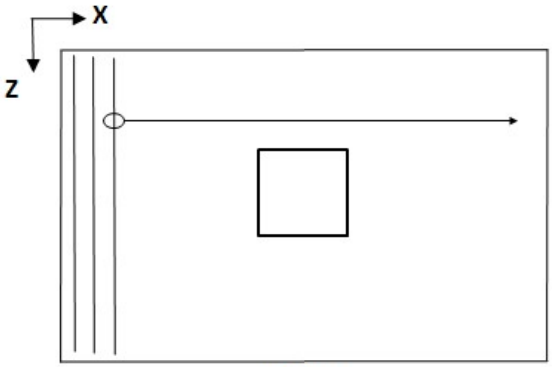
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.700 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 500.013 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 73.760 mm

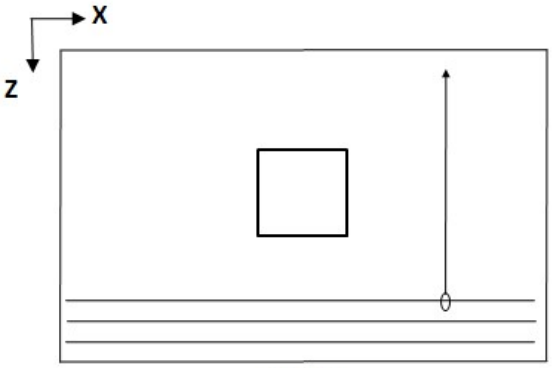
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 608.412 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.760 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

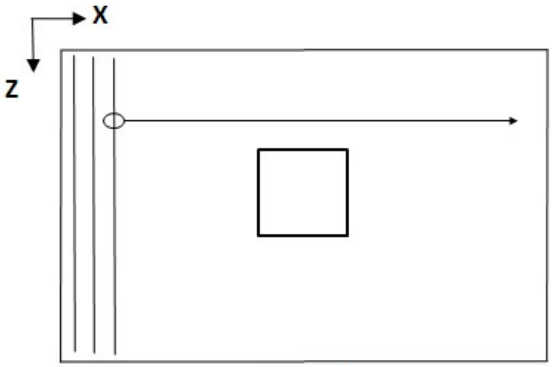
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 713.700 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.646 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 73.760 mm

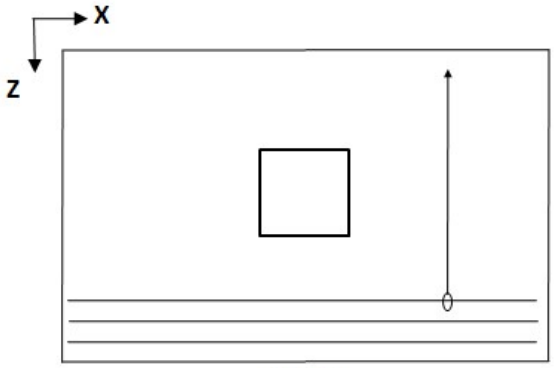
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 713.700 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 5.287 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.760 mm

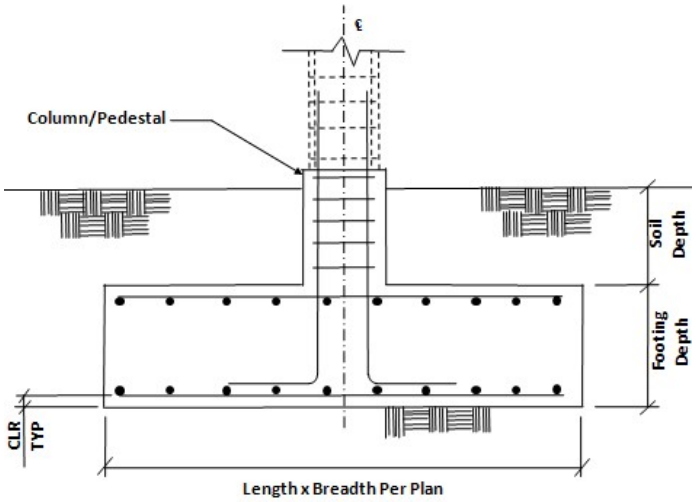
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

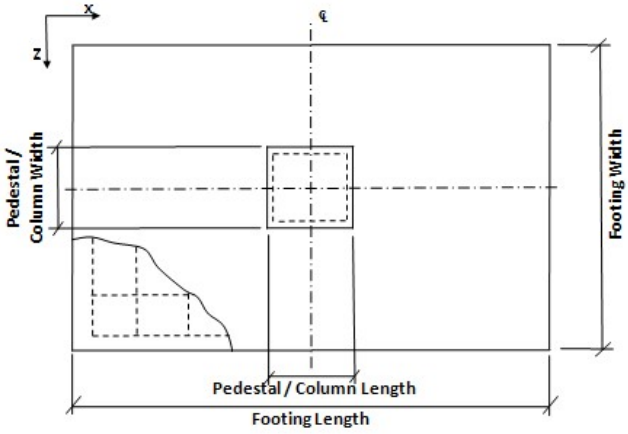
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 37



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal? No
Pedestal Shape : N/A
Pedestal Height (Ph) : N/A
Pedestal Length - X (Pl) : N/A
Pedestal Width - Z (Pw) : N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3
Strength of Concrete : 25.000 N/mm2
Yield Strength of Steel : 415.000 N/mm2
Minimum Bar Size : Ø6
Maximum Bar Size : Ø32
Minimum Bar Spacing : 50.000 mm
Maximum Bar Spacing : 500.000 mm
Pedestal Clear Cover (P, CL) : 50.000 mm
Footing Clear Cover (F, CL) : 50.000 mm

Soil Properties

Soil Type : Drained
Unit Weight : 22.000 kN/m3
Soil Bearing Capacity : 100.000 kN/m2
Soil Surcharge : 0.000 kN/m2
Depth of Soil above Footing : 0.000 mm
Cohesion : 0.000 kN/m2
Min Percentage of Slab : 0.000

Sliding and Overturning

Coefficient of Friction : 0.500
Factor of Safety Against Sliding : 1.500
Factor of Safety Against Overturning : 1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.815	0.014	0.813	0.786	0.089
2	483.319	-0.017	3.554	3.431	0.399
4	120.830	-0.004	0.889	0.858	0.100
5	0.019	-0.002	0.000	0.000	0.002
6	0.015	0.008	-0.019	-0.016	-0.018

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.815	0.014	0.813	0.786	0.089
2	483.319	-0.017	3.554	3.431	0.399
4	120.830	-0.004	0.889	0.858	0.100
5	0.019	-0.002	0.000	0.000	0.002
6	0.015	0.008	-0.019	-0.016	-0.018

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 4.909 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

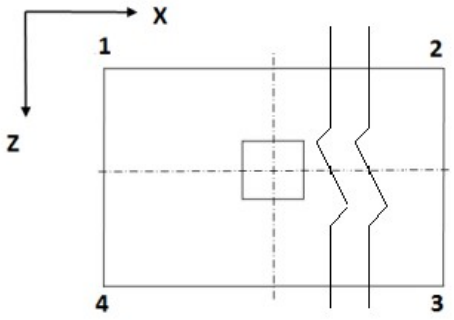
Length (L_2) = 2.350 m Governing Load Case : # 2

Width (W_2) = 2.350 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 5.523 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**93.2426**	92.8689	97.0436	97.4173	0.000
2	93.2426	**92.8689**	97.0436	97.4173	0.000
2	93.2426	92.8689	**97.0436**	97.4173	0.000
2	93.2426	92.8689	97.0436	**97.4173**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**93.2426**	92.8689	97.0436	97.4173
2	93.2426	**92.8689**	97.0436	97.4173
2	93.2426	92.8689	**97.0436**	97.4173
2	93.2426	92.8689	97.0436	**97.4173**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	8202.213	141.322	261.332	3195.090
2	15705.035	73.912	136.742	1527.686
4	19480.956	91.682	169.619	1894.983
5	11367.505	319151.324	581467.991	23934.439
6	2574.840	1127.828	2306.021	2390.668

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 6
Governing Disturbing Force : 0.008 kN
Governing Restoring Force : 21.062 kN
Minimum Sliding Ratio for the Critical Load Case : 2574.840
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 4.515 kNm
Governing Resisting Moment : 617.366 kNm
Minimum Overturning Ratio for the Critical Load Case : 136.742

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 3.554 kN
Governing Restoring Force : 262.714 kN
Minimum Sliding Ratio for the Critical Load Case : 73.912
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 0.404 kNm
Governing Resisting Moment : 617.366 kNm
Minimum Overturning Ratio for the Critical Load Case : 1527.686

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 94.424 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 102.989 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

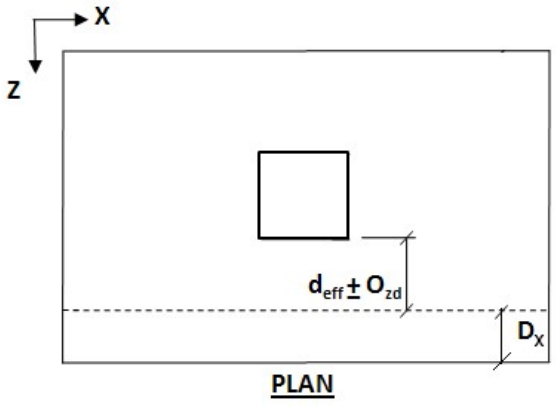
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 145.963 kN

Shear Stress(T_v) = 246.475560 kN/m2

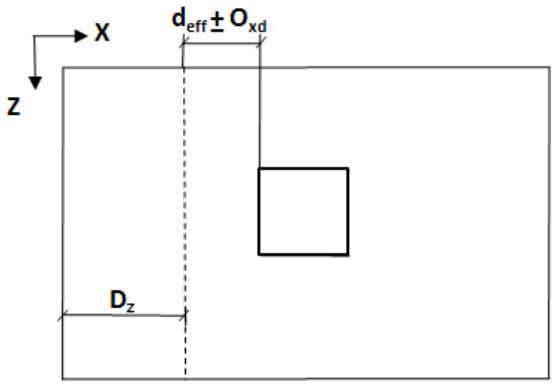
Percentage Of Steel(P_t) = 0.1976

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 329.021 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 154.063 kN

Shear Stress(T_v) = 260.153953 kN/m2

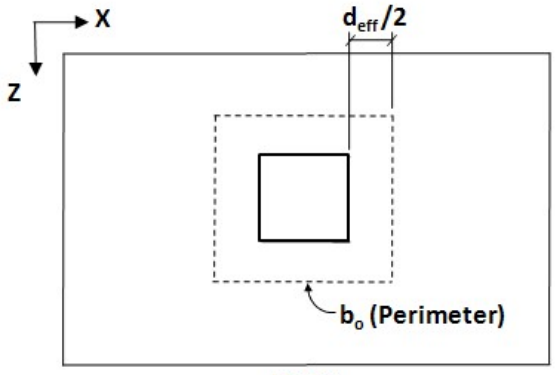
Percentage Of Steel(P_t) = 0.1807

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 316.189 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 446.333 kN

Shear Stress(T_v) = 679.127 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.950 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

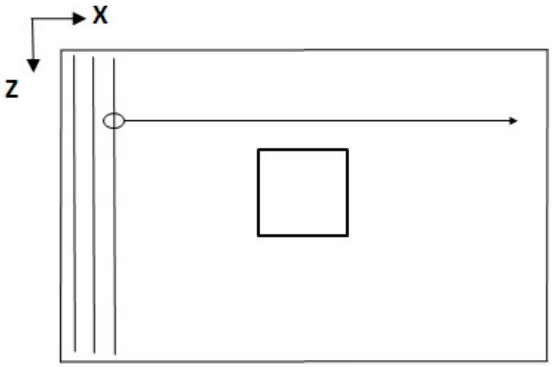
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.900 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1069.911 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1069.911 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 60.649 mm

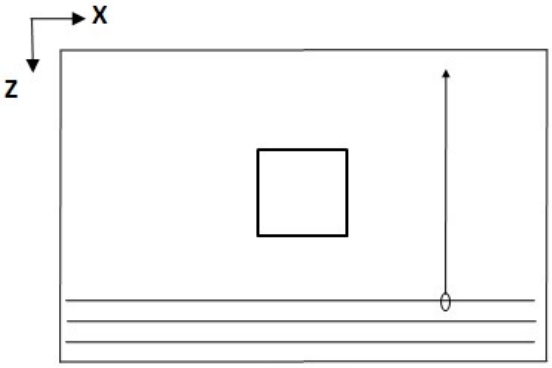
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 60.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1170.355 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1170.355 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 54.732 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

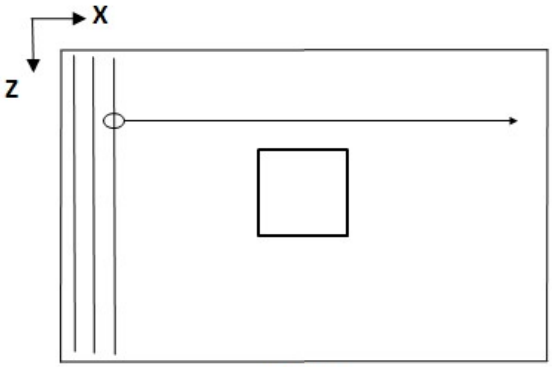
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 8.984 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.800 mm

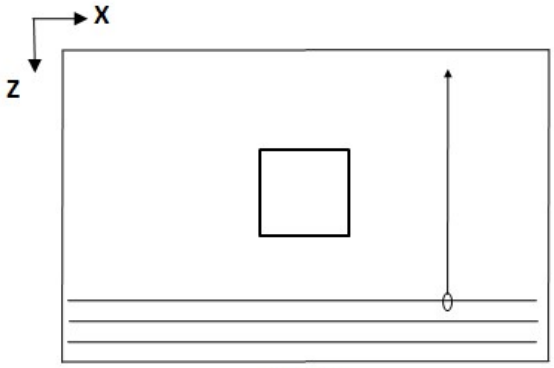
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 9.955 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.800 mm

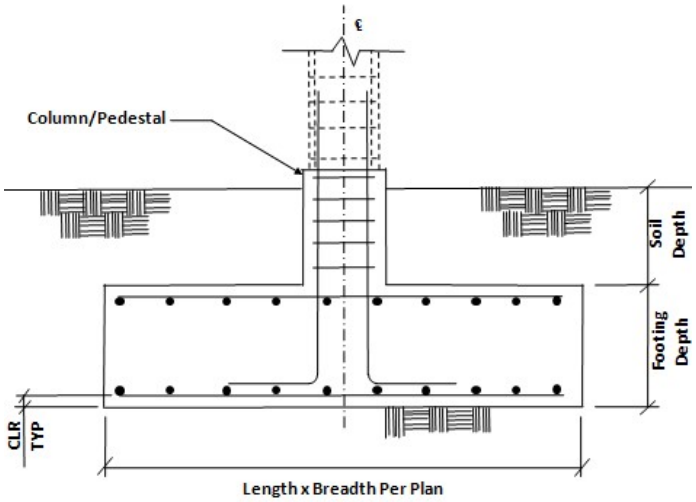
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

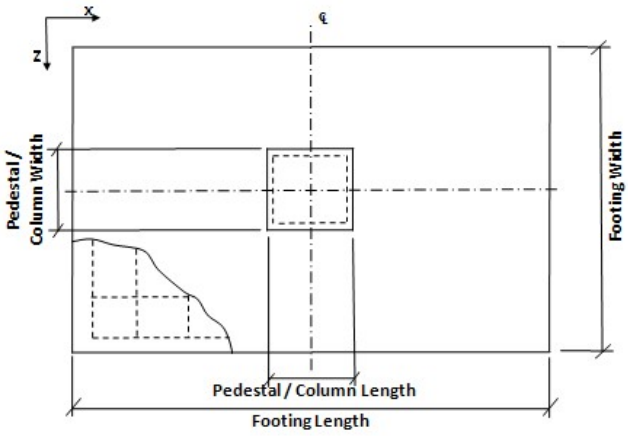
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 38



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal? No
Pedestal Shape : N/A
Pedestal Height (Ph) : N/A
Pedestal Length - X (Pl) : N/A
Pedestal Width - Z (Pw) : N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3
Strength of Concrete : 25.000 N/mm2
Yield Strength of Steel : 415.000 N/mm2
Minimum Bar Size : Ø6
Maximum Bar Size : Ø32
Minimum Bar Spacing : 50.000 mm
Maximum Bar Spacing : 500.000 mm
Pedestal Clear Cover (P, CL) : 50.000 mm
Footing Clear Cover (F, CL) : 50.000 mm

Soil Properties

Soil Type : Drained
Unit Weight : 22.000 kN/m3
Soil Bearing Capacity : 100.000 kN/m2
Soil Surcharge : 0.000 kN/m2
Depth of Soil above Footing : 0.000 mm
Cohesion : 0.000 kN/m2
Min Percentage of Slab : 0.000

Sliding and Overturning

Coefficient of Friction : 0.500
Factor of Safety Against Sliding : 1.500
Factor of Safety Against Overturning : 1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.882	-0.167	0.815	0.787	0.246
2	484.951	-0.610	3.572	3.448	0.901
4	121.238	-0.153	0.893	0.862	0.225
5	0.018	0.023	0.000	0.000	-0.018
6	0.015	0.008	-0.019	-0.016	-0.019

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.882	-0.167	0.815	0.787	0.246
2	484.951	-0.610	3.572	3.448	0.901
4	121.238	-0.153	0.893	0.862	0.225
5	0.018	0.023	0.000	0.000	-0.018
6	0.015	0.008	-0.019	-0.016	-0.019

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 4.926 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

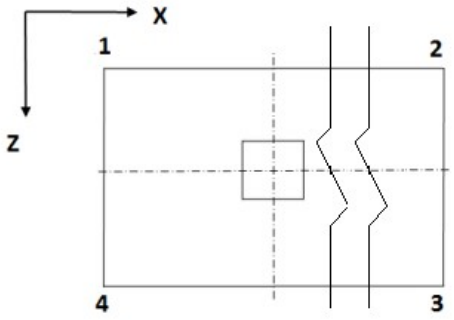
Length (L_2) = 2.350 m Governing Load Case : # 2

Width (W_2) = 2.350 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 5.523 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**93.8436**	92.8386	97.0338	98.0388	0.000
2	93.8436	**92.8386**	97.0338	98.0388	0.000
2	93.8436	92.8386	**97.0338**	98.0388	0.000
2	93.8436	92.8386	97.0338	**98.0388**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**93.8436**	92.8386	97.0338	98.0388
2	93.8436	**92.8386**	97.0338	98.0388
2	93.8436	92.8386	**97.0338**	98.0388
2	93.8436	92.8386	97.0338	**98.0388**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	687.193	141.083	260.879	909.332
2	432.004	73.782	136.497	569.792
4	535.549	91.467	169.212	706.362
5	916.130	421273.299	808156.949	1952.681
6	2503.239	1131.041	2325.220	2336.354

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -0.610 kN
Governing Restoring Force : 263.530 kN
Minimum Sliding Ratio for the Critical Load Case : 432.004
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 4.537 kNm
Governing Resisting Moment : 619.284 kNm
Minimum Overturning Ratio for the Critical Load Case : 136.497

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 3.572 kN
Governing Restoring Force : 263.530 kN
Minimum Sliding Ratio for the Critical Load Case : 73.782
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 1.087 kNm
Governing Resisting Moment : 619.284 kNm
Minimum Overturning Ratio for the Critical Load Case : 569.792

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 94.746 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 103.602 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

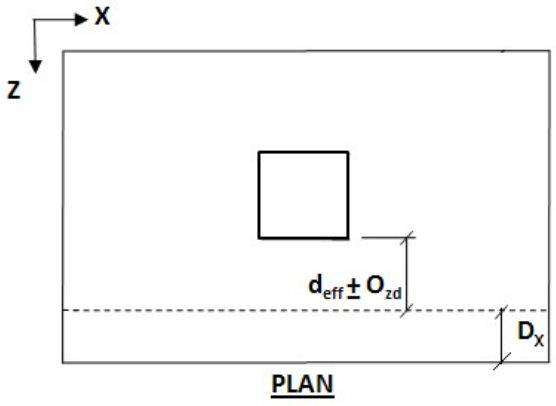
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 146.460 kN

Shear Stress(T_v) = 247.314299 kN/m2

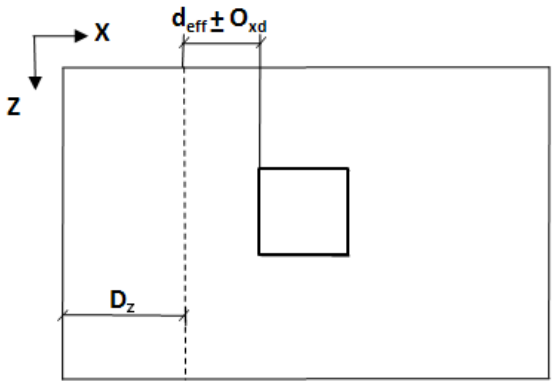
Percentage Of Steel(P_t) = 0.1988

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 329.915 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 154.961 kN

Shear Stress(T_v) = 261.670094 kN/m2

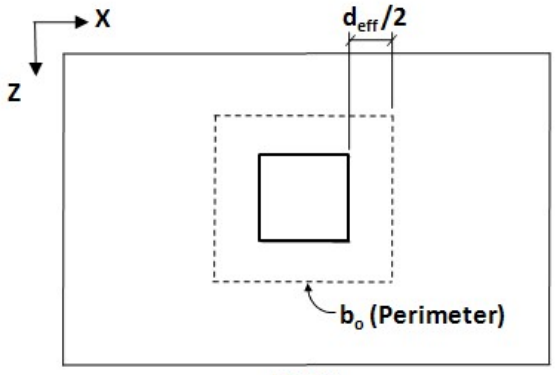
Percentage Of Steel(P_t) = 0.1813

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 316.683 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 447.841 kN

Shear Stress(T_v) = 681.421 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.950 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

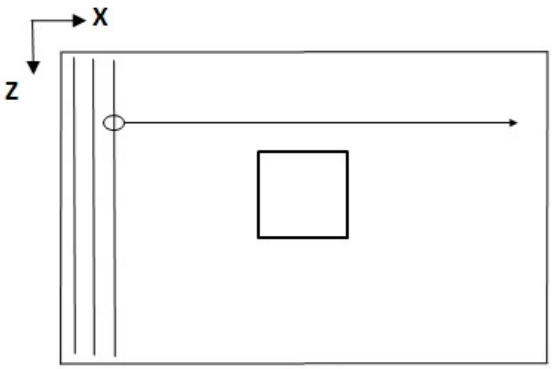
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.900 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1073.669 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1073.669 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 60.649 mm

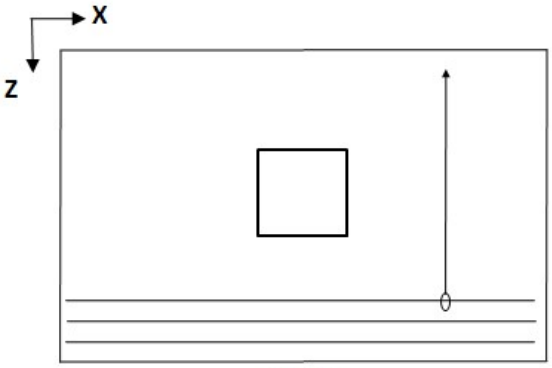
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 60.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1177.566 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1177.566 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 54.732 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

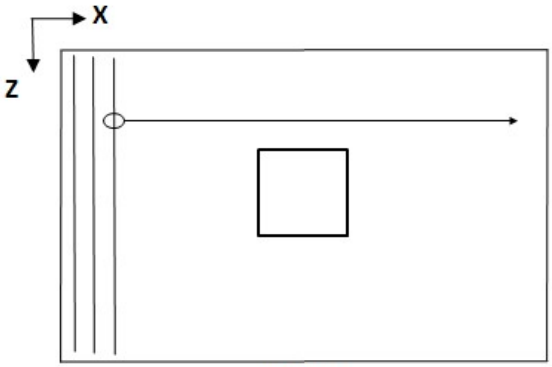
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 8.984 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.800 mm

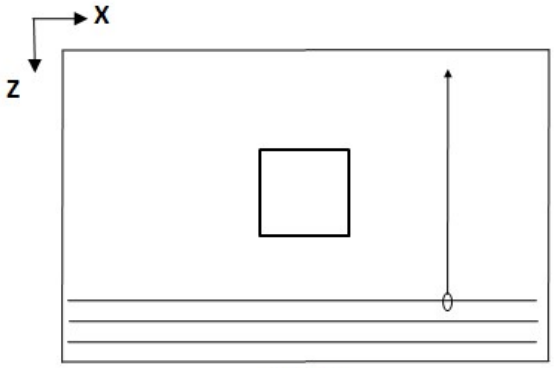
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin}<= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 9.955 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.800 mm

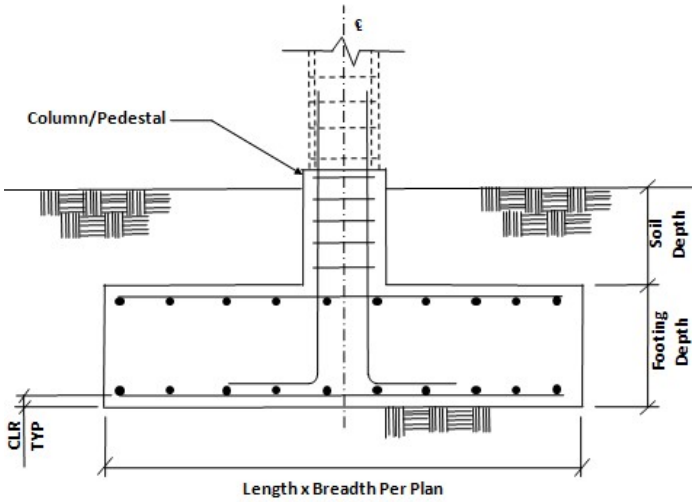
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

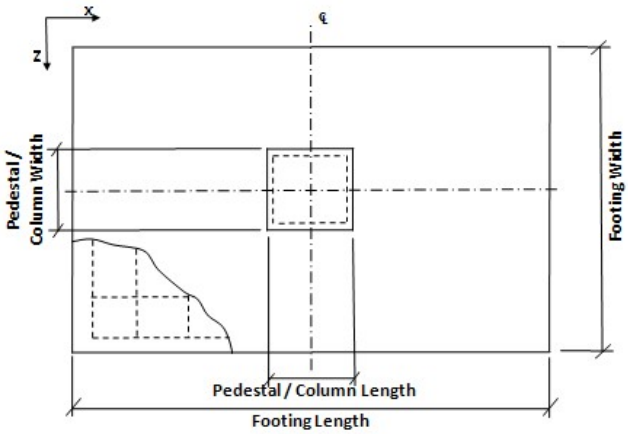
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 39



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	149.351	2.503	1.330	1.301	-2.398
2	234.210	9.466	1.851	1.806	-9.076
4	58.553	2.367	0.463	0.451	-2.269
5	-0.029	0.059	0.004	0.004	-0.051
6	0.016	0.006	-0.006	-0.005	-0.016

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	149.351	2.503	1.330	1.301	-2.398
2	234.210	9.466	1.851	1.806	-9.076
4	58.553	2.367	0.463	0.451	-2.269
5	-0.029	0.059	0.004	0.004	-0.051
6	0.016	0.006	-0.006	-0.005	-0.016

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 2.418 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

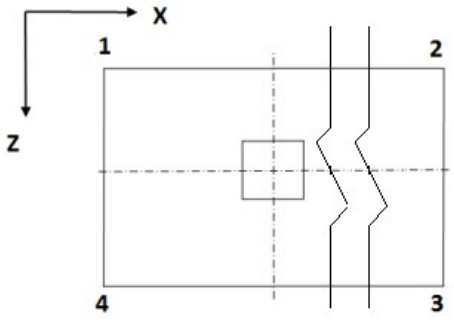
Length (L_2) = 1.800 m Governing Load Case : # 2

Width (W_2) = 1.800 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.240 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**65.1656**	89.7815	94.6587	70.0428	0.000
2	65.1656	**89.7815**	94.6587	70.0428	0.000
2	65.1656	89.7815	**94.6587**	70.0428	0.000
2	65.1656	89.7815	94.6587	**70.0428**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**65.1656**	89.7815	94.6587	70.0428
2	65.1656	**89.7815**	94.6587	70.0428
2	65.1656	89.7815	**94.6587**	70.0428
2	65.1656	89.7815	94.6587	**70.0428**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.240 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	34.763	65.434	91.791	49.548
2	13.676	69.928	98.309	19.478
4	17.590	89.945	126.450	25.054
5	208.720	2860.626	4594.672	321.969
6	2055.291	2007.230	3037.734	1217.701

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : 9.466 kN
Governing Restoring Force : 129.458 kN
Minimum Sliding Ratio for the Critical Load Case : 13.676
Critical Load Case for Overturning about X-Direction : 1
Governing Overturning Moment : 1.707 kNm
Governing Resisting Moment : 156.647 kNm
Minimum Overturning Ratio for the Critical Load Case : 91.791

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 1
Governing Disturbing Force : 1.330 kN
Governing Restoring Force : 87.028 kN
Minimum Sliding Ratio for the Critical Load Case : 65.434
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : -11.963 kNm
Governing Resisting Moment : 233.020 kNm
Minimum Overturning Ratio for the Critical Load Case : 19.478

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 30.393 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 393.700096 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 38.459 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

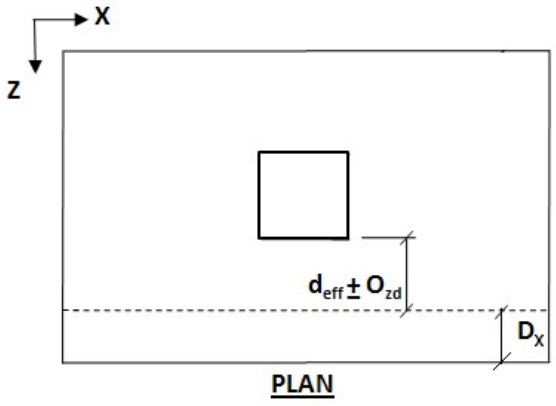
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 393.700096 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 56.460 kN

Shear Stress(T_v) = 124.470588 kN/m2

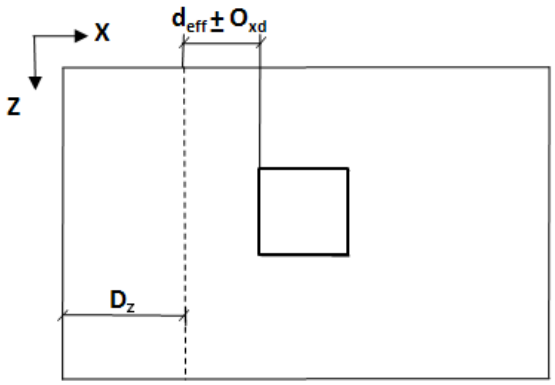
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 69.271 kN

Shear Stress(T_v) = 152.713029 kN/m2

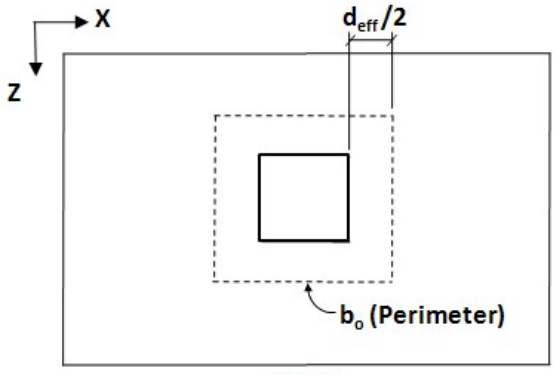
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 203.662 kN

Shear Stress(T_v) = 309.885 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

K_s x T_c = 1250.0000 kN/m2

$T_v <= K_s$ x T_c hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.675 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

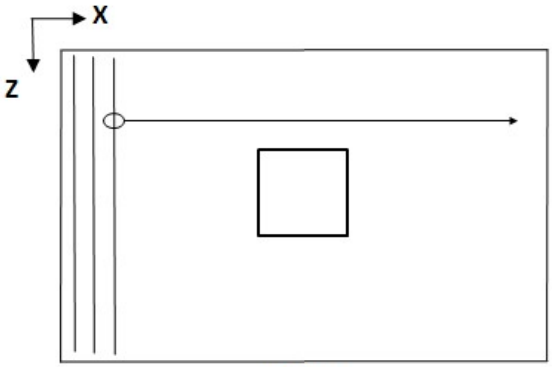
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.484 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.625 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 338.234 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 73.652 mm

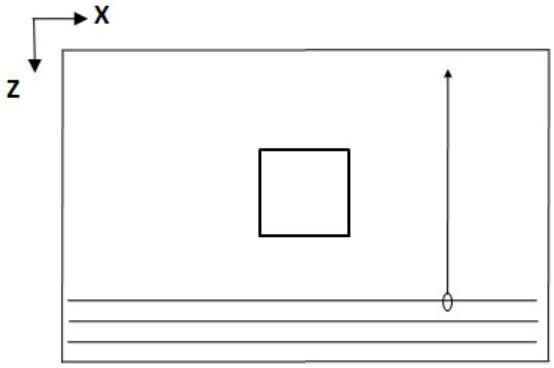
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 429.452 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.652 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

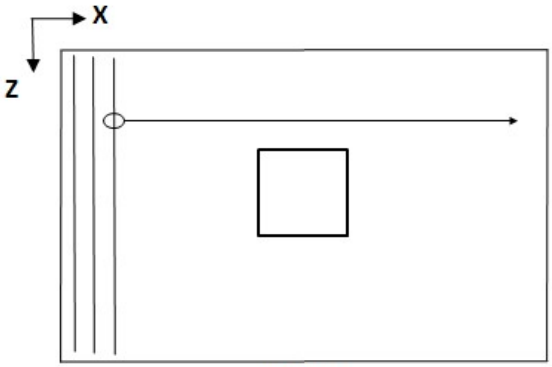
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 658.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 3.474 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 73.652 mm

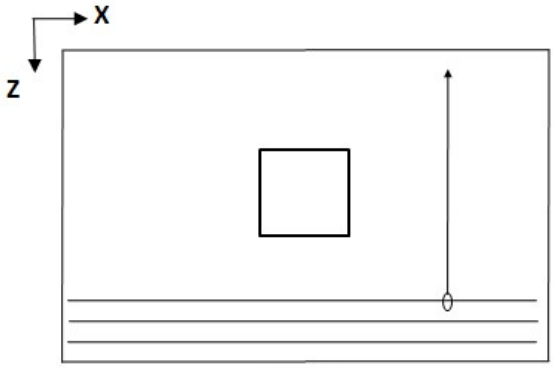
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 658.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin}<= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.008 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.652 mm

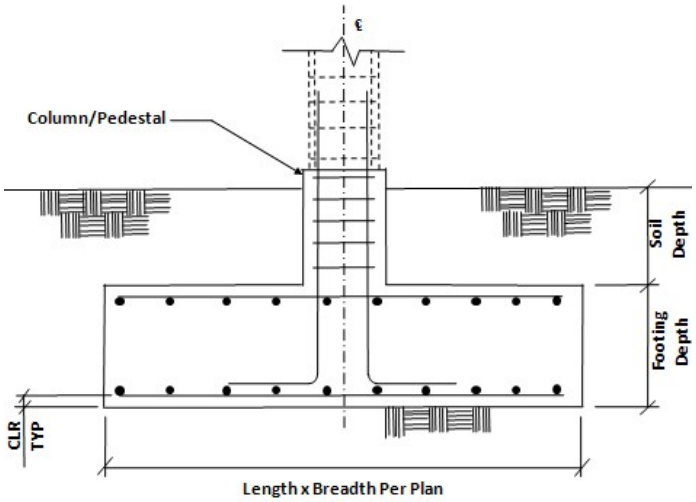
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

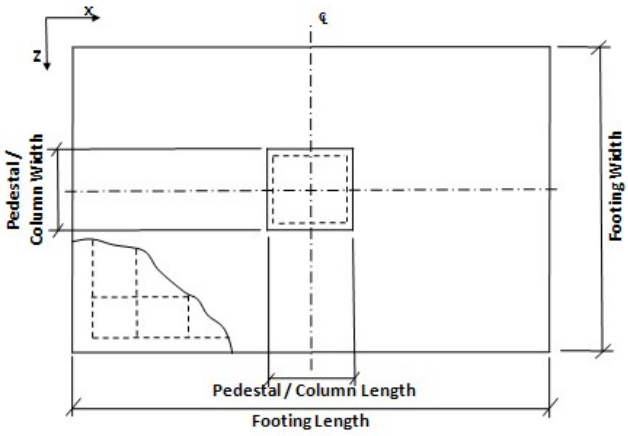
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 40



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	227.514	-1.576	-1.163	-1.134	1.671
2	309.201	-7.012	-0.302	-0.297	7.345
4	77.300	-1.753	-0.076	-0.074	1.836
5	0.071	-0.021	-0.002	-0.001	0.016
6	0.022	0.010	0.009	0.008	-0.020

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	227.514	-1.576	-1.163	-1.134	1.671
2	309.201	-7.012	-0.302	-0.297	7.345
4	77.300	-1.753	-0.076	-0.074	1.836
5	0.071	-0.021	-0.002	-0.001	0.016
6	0.022	0.010	0.009	0.008	-0.020

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 3.168 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

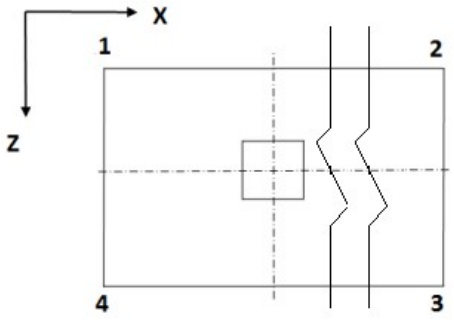
Length (L_2) = 1.950 m Governing Load Case : # 2

Width (W_2) = 1.950 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.803 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**96.9292**	81.5819	80.9512	96.2986	0.000
2	96.9292	**81.5819**	80.9512	96.2986	0.000
2	96.9292	81.5819	**80.9512**	96.2986	0.000
2	96.9292	81.5819	80.9512	**96.2986**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**96.9292**	81.5819	80.9512	96.2986
2	96.9292	**81.5819**	80.9512	96.2986
2	96.9292	81.5819	**80.9512**	96.2986
2	96.9292	81.5819	80.9512	**96.2986**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.803 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	81.356	110.319	167.995	116.208
2	24.116	559.135	846.152	34.771
4	30.319	702.940	1063.771	43.714
5	681.230	7889.618	20948.042	1249.912
6	1463.993	1664.736	2699.240	1245.170

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -7.012 kN
Governing Restoring Force : 169.098 kN
Minimum Sliding Ratio for the Critical Load Case : 24.116
Critical Load Case for Overturning about X-Direction : 1
Governing Overturning Moment : -1.489 kNm
Governing Resisting Moment : 250.091 kNm
Minimum Overturning Ratio for the Critical Load Case : 167.995

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 1
Governing Disturbing Force : -1.163 kN
Governing Restoring Force : 128.254 kN
Minimum Sliding Ratio for the Critical Load Case : 110.319
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 9.483 kNm
Governing Resisting Moment : 329.734 kNm
Minimum Overturning Ratio for the Critical Load Case : 34.771

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 44.724 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 426.508437 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 54.217 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

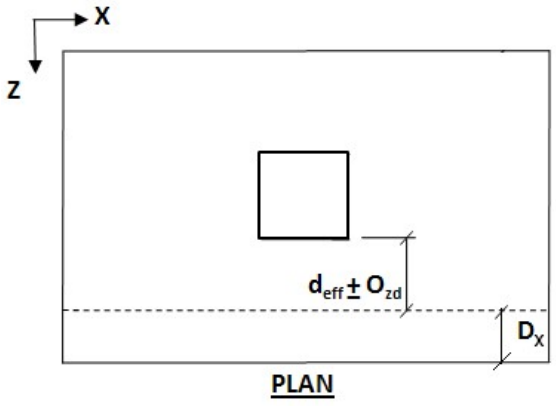
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 426.508437 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 79.193 kN

Shear Stress(T_v) = 161.158403 kN/m2

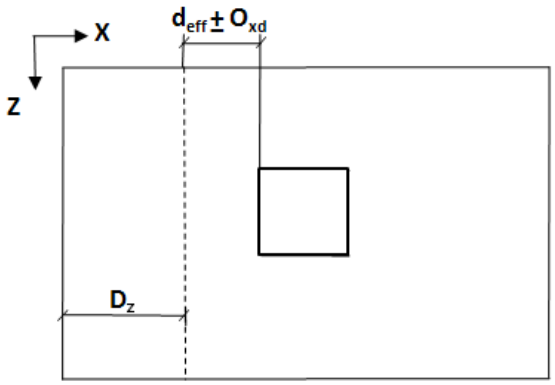
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 92.789 kN

Shear Stress(T_v) = 188.826033 kN/m2

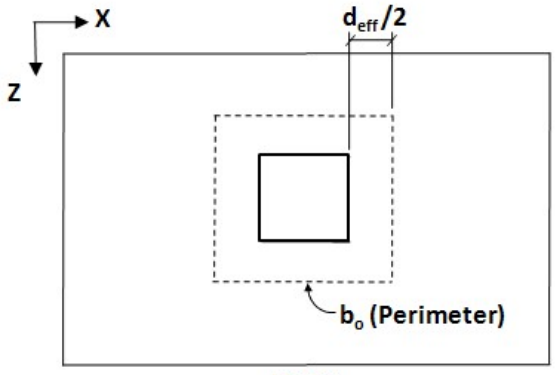
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 274.837 kN

Shear Stress(T_v) = 418.184 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.750 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

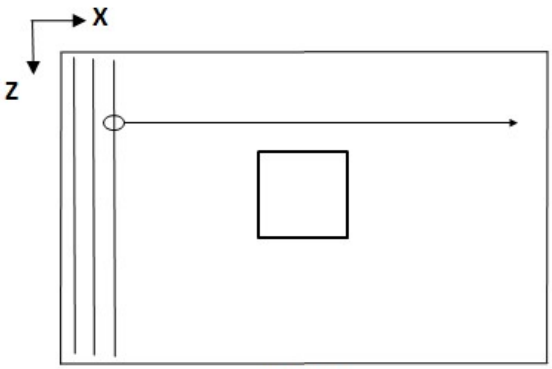
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.700 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 500.011 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 73.760 mm

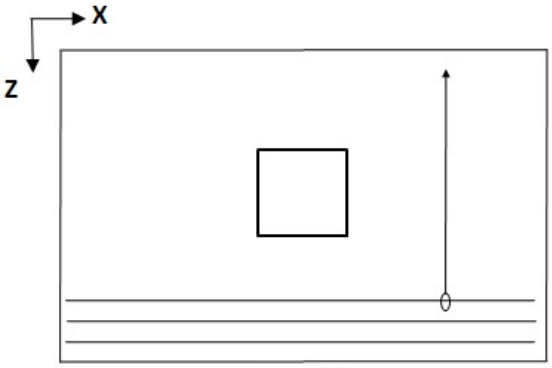
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 608.412 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.760 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

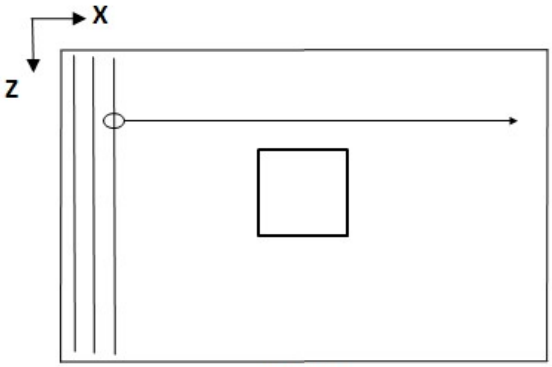
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 713.700 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.646 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 73.760 mm

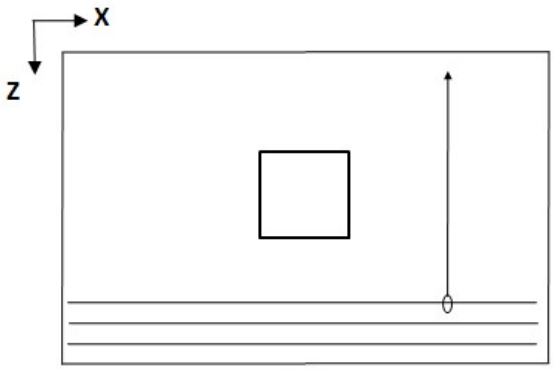
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 713.700 mm2

Calculated Area of Steel (A_{st}) = 713.700 mm2

Provided Area of Steel ($A_{st,Provided}$) = 713.700 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 5.287 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.760 mm

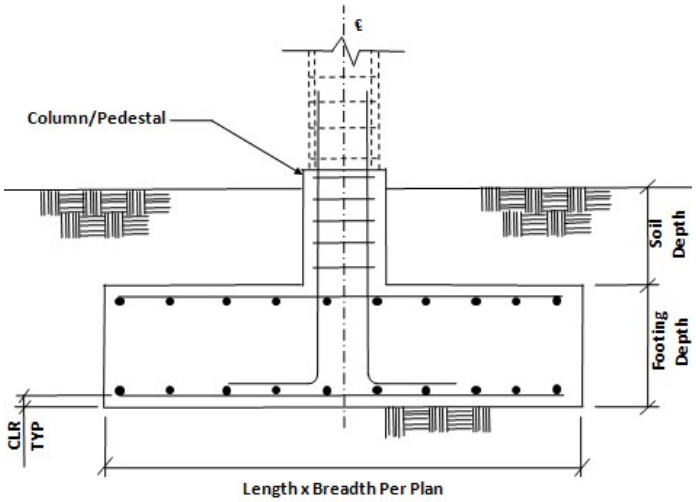
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

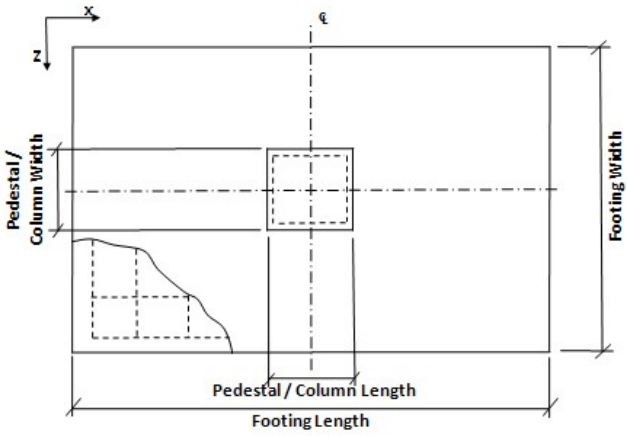
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 41



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.815	0.014	-0.813	-0.786	0.089
2	483.319	-0.017	-3.554	-3.431	0.399
4	120.830	-0.004	-0.889	-0.858	0.100
5	0.019	-0.002	-0.000	-0.000	0.002
6	0.015	0.008	0.019	0.016	-0.018

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.815	0.014	-0.813	-0.786	0.089
2	483.319	-0.017	-3.554	-3.431	0.399
4	120.830	-0.004	-0.889	-0.858	0.100
5	0.019	-0.002	-0.000	-0.000	0.002
6	0.015	0.008	0.019	0.016	-0.018

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 4.909 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

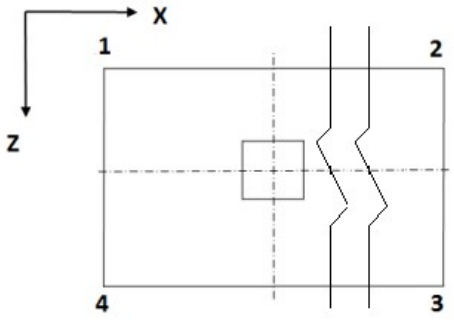
Length (L_2) = 2.350 m Governing Load Case : # 2

Width (W_2) = 2.350 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 5.523 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**97.4173**	97.0436	92.8689	93.2426	0.000
2	97.4173	**97.0436**	92.8689	93.2426	0.000
2	97.4173	97.0436	**92.8689**	93.2426	0.000
2	97.4173	97.0436	92.8689	**93.2426**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**97.4173**	97.0436	92.8689	93.2426
2	97.4173	**97.0436**	92.8689	93.2426
2	97.4173	97.0436	**92.8689**	93.2426
2	97.4173	97.0436	92.8689	**93.2426**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	8202.213	141.322	261.332	3195.090
2	15705.035	73.912	136.742	1527.682
4	19480.955	91.682	169.619	1894.983
5	11367.505	319151.324	581467.991	23934.439
6	2574.840	1127.828	2306.021	2390.668

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 6
Governing Disturbing Force : 0.008 kN
Governing Restoring Force : 21.062 kN
Minimum Sliding Ratio for the Critical Load Case : 2574.840
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : -4.515 kNm
Governing Resisting Moment : 617.366 kNm
Minimum Overturning Ratio for the Critical Load Case : 136.742

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : -3.554 kN
Governing Restoring Force : 262.714 kN
Minimum Sliding Ratio for the Critical Load Case : 73.912
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 0.404 kNm
Governing Resisting Moment : 617.366 kNm
Minimum Overturning Ratio for the Critical Load Case : 1527.682

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 94.422 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 102.989 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

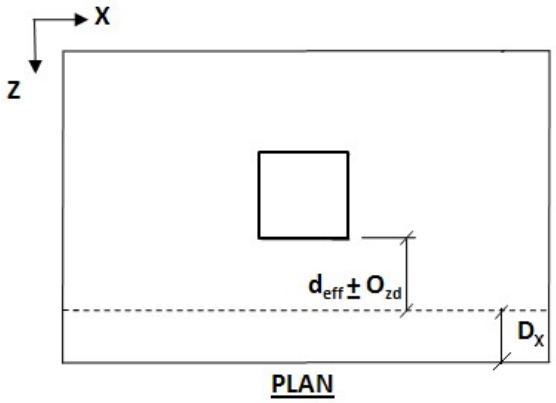
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 145.963 kN

Shear Stress(T_v) = 246.475544 kN/m2

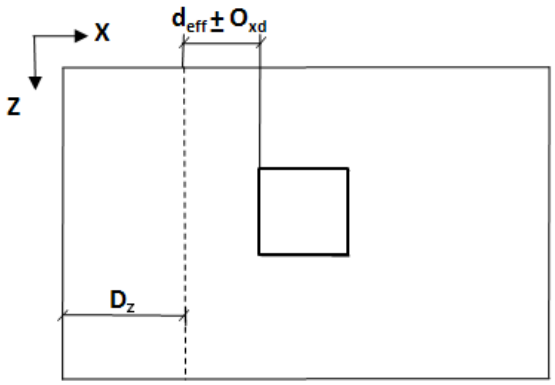
Percentage Of Steel(P_t) = 0.1976

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 329.021 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 154.063 kN

Shear Stress(T_v) = 260.153937 kN/m2

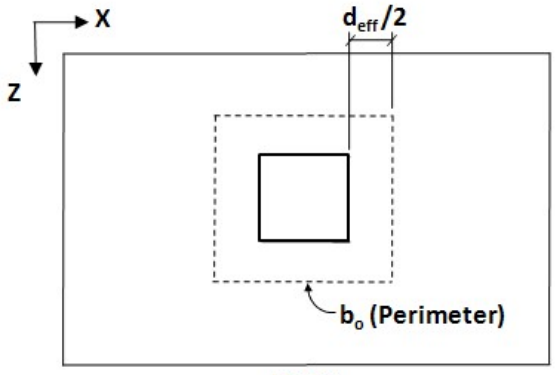
Percentage Of Steel(P_t) = 0.1807

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 316.186 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 446.333 kN

Shear Stress(T_v) = 679.127 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.950 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

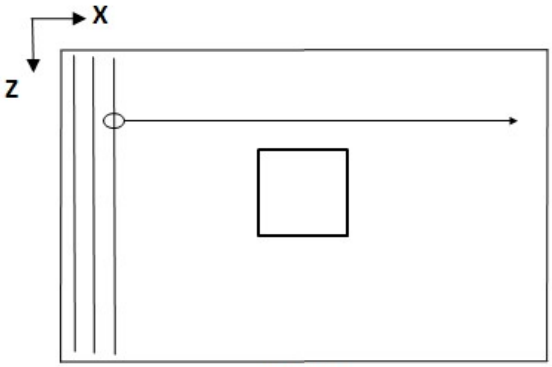
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.900 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1069.887 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1069.887 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 60.649 mm

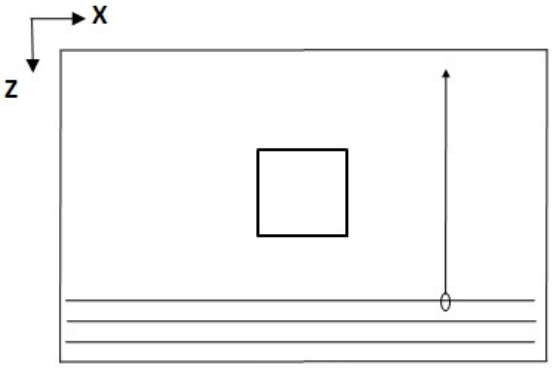
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 60.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1170.355 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1170.355 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 54.732 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

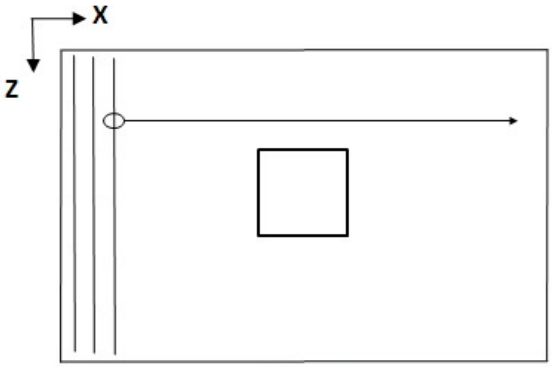
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 8.984 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.800 mm

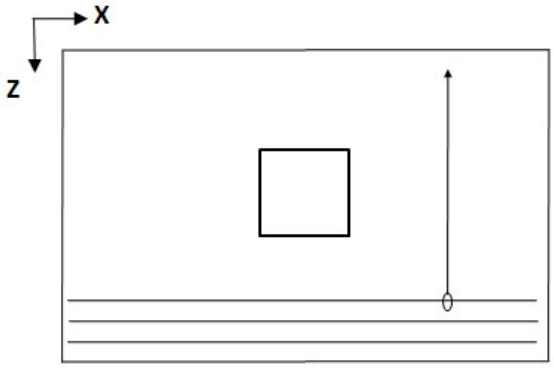
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 9.955 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.800 mm

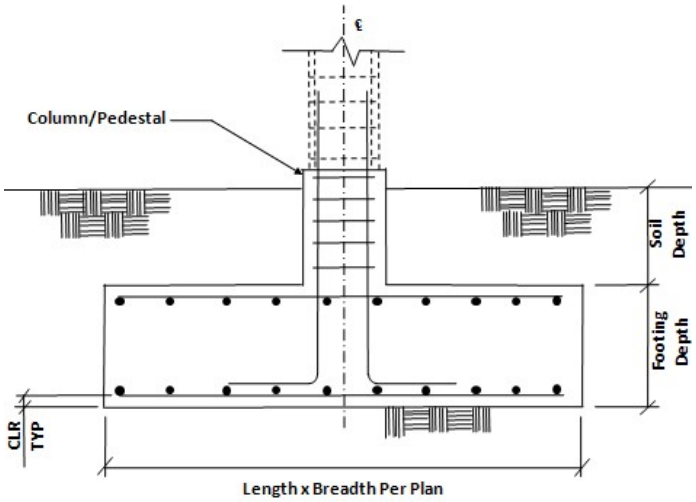
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

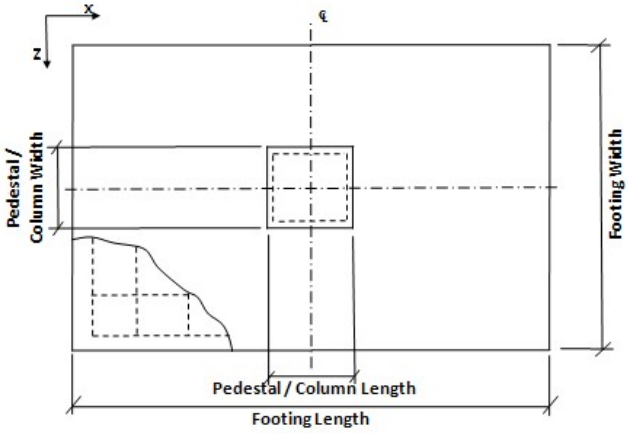
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 42



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.882	-0.167	-0.815	-0.787	0.246
2	484.951	-0.610	-3.572	-3.448	0.901
4	121.238	-0.153	-0.893	-0.862	0.225
5	0.018	0.023	-0.000	-0.000	-0.018
6	0.015	0.008	0.019	0.016	-0.019

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	187.882	-0.167	-0.815	-0.787	0.246
2	484.951	-0.610	-3.572	-3.448	0.901
4	121.238	-0.153	-0.893	-0.862	0.225
5	0.018	0.023	-0.000	-0.000	-0.018
6	0.015	0.008	0.019	0.016	-0.019

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 4.926 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

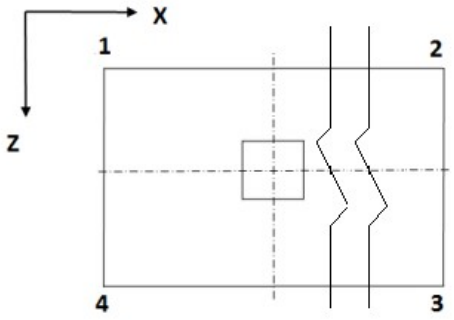
Length (L_2) = 2.350 m Governing Load Case : # 2

Width (W_2) = 2.350 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 5.523 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**98.0388**	97.0338	92.8386	93.8436	0.000
2	98.0388	**97.0338**	92.8386	93.8436	0.000
2	98.0388	97.0338	**92.8386**	93.8436	0.000
2	98.0388	97.0338	92.8386	**93.8436**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**98.0388**	97.0338	92.8386	93.8436
2	98.0388	**97.0338**	92.8386	93.8436
2	98.0388	97.0338	**92.8386**	93.8436
2	98.0388	97.0338	92.8386	**93.8436**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	687.193	141.083	260.879	909.332
2	432.004	73.782	136.497	569.792
4	535.549	91.467	169.212	706.362
5	916.130	421273.299	808156.949	1952.604
6	2503.239	1131.041	2325.220	2336.354

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -0.610 kN
Governing Restoring Force : 263.530 kN
Minimum Sliding Ratio for the Critical Load Case : 432.004
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : -4.537 kNm
Governing Resisting Moment : 619.284 kNm
Minimum Overturning Ratio for the Critical Load Case : 136.497

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : -3.572 kN
Governing Restoring Force : 263.530 kN
Minimum Sliding Ratio for the Critical Load Case : 73.782
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 1.087 kNm
Governing Resisting Moment : 619.284 kNm
Minimum Overturning Ratio for the Critical Load Case : 569.792

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 94.744 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 103.602 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

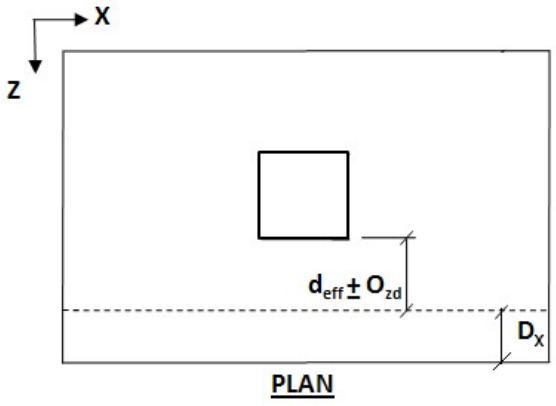
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 513.997347 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 146.460 kN

Shear Stress(T_v) = 247.314299 kN/m2

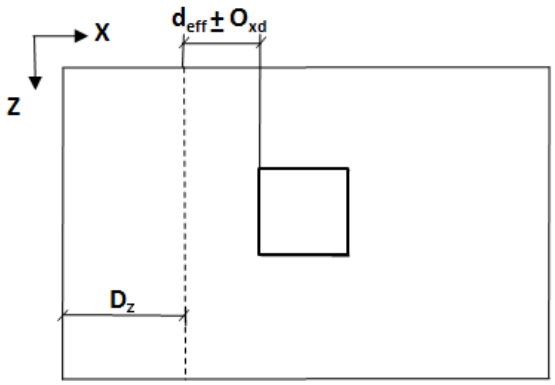
Percentage Of Steel(P_t) = 0.1988

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 329.915 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 154.961 kN

Shear Stress(T_v) = 261.670094 kN/m2

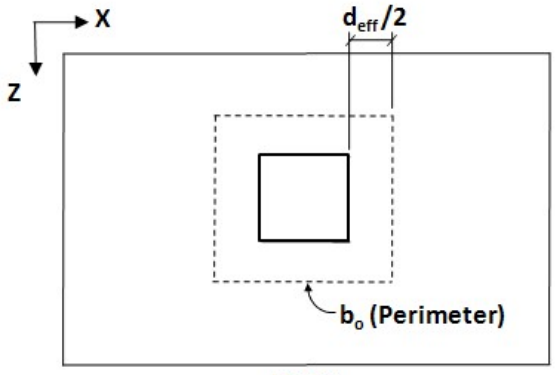
Percentage Of Steel(P_t) = 0.1813

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 316.680 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 447.841 kN

Shear Stress(T_v) = 681.421 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

K_s x T_c = 1250.0000 kN/m2

$T_v <= K_s$ x T_c hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.950 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 20 mm

As Per IS 456 2000 Clause 26.2.1

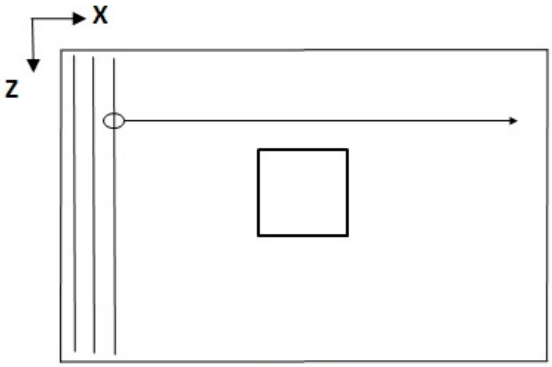
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.806 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.900 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1073.646 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1073.646 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 60.649 mm

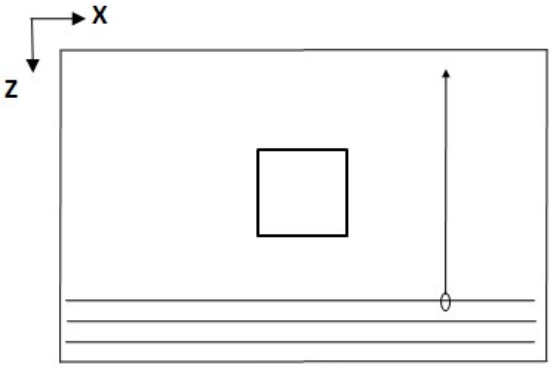
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 60.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 1177.566 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1177.566 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 54.732 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

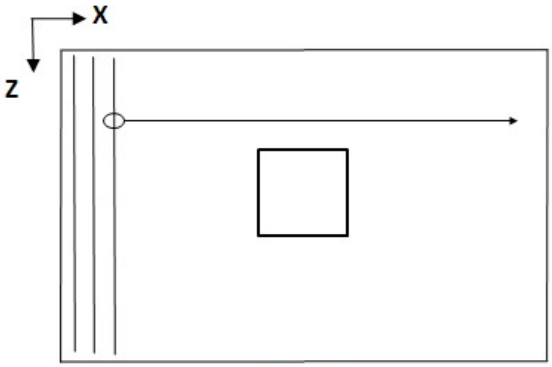
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 8.984 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.800 mm

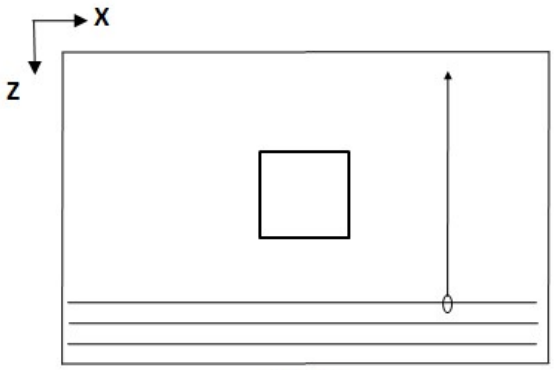
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 860.100 mm2

Calculated Area of Steel (A_{st}) = 860.100 mm2

Provided Area of Steel ($A_{st,Provided}$) = 860.100 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 9.955 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.800 mm

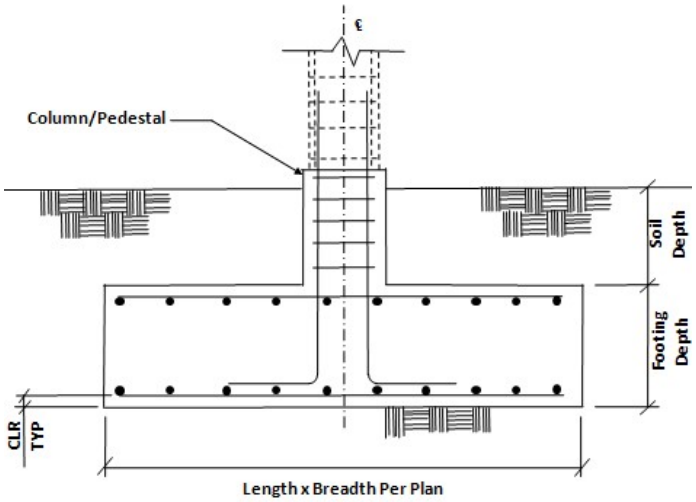
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

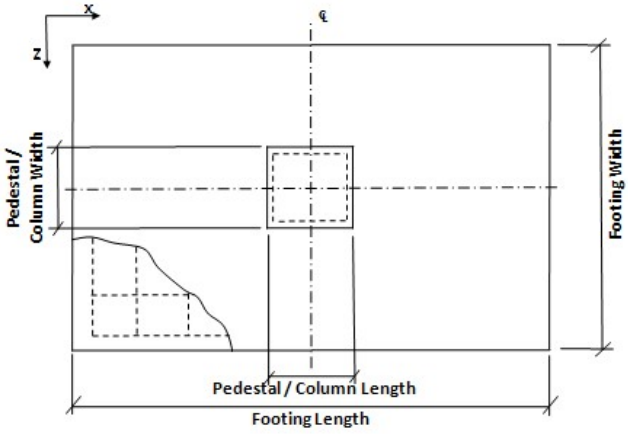
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 43



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	149.351	2.503	-1.330	-1.301	-2.398
2	234.210	9.466	-1.851	-1.806	-9.076
4	58.553	2.367	-0.463	-0.451	-2.269
5	-0.029	0.059	-0.004	-0.004	-0.051
6	0.016	0.006	0.006	0.005	-0.016

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	149.351	2.503	-1.330	-1.301	-2.398
2	234.210	9.466	-1.851	-1.806	-9.076
4	58.553	2.367	-0.463	-0.451	-2.269
5	-0.029	0.059	-0.004	-0.004	-0.051
6	0.016	0.006	0.006	0.005	-0.016

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 2.418 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

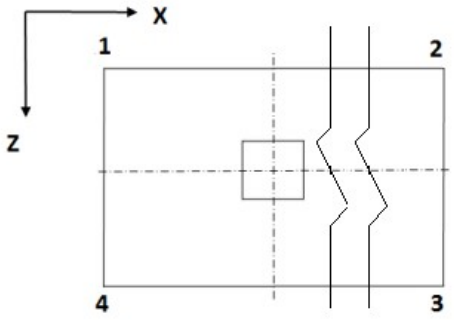
Length (L_2) = 1.800 m Governing Load Case : # 2

Width (W_2) = 1.800 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.240 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**70.0428**	94.6587	89.7815	65.1656	0.000
2	70.0428	**94.6587**	89.7815	65.1656	0.000
2	70.0428	94.6587	**89.7815**	65.1656	0.000
2	70.0428	94.6587	89.7815	**65.1656**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**70.0428**	94.6587	89.7815	65.1656
2	70.0428	**94.6587**	89.7815	65.1656
2	70.0428	94.6587	**89.7815**	65.1656
2	70.0428	94.6587	89.7815	**65.1656**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.240 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	34.763	65.434	91.791	49.548
2	13.676	69.928	98.309	19.478
4	17.590	89.945	126.450	25.054
5	208.720	2860.626	4594.672	321.969
6	2055.291	2007.230	3037.734	1217.701

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : 9.466 kN
Governing Restoring Force : 129.458 kN
Minimum Sliding Ratio for the Critical Load Case : 13.676
Critical Load Case for Overturning about X-Direction : 1
Governing Overturning Moment : -1.707 kNm
Governing Resisting Moment : 156.647 kNm
Minimum Overturning Ratio for the Critical Load Case : 91.791

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 1
Governing Disturbing Force : -1.330 kN
Governing Restoring Force : 87.028 kN
Minimum Sliding Ratio for the Critical Load Case : 65.434
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : -11.963 kNm
Governing Resisting Moment : 233.020 kNm
Minimum Overturning Ratio for the Critical Load Case : 19.478

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 30.391 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 393.700096 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 38.459 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

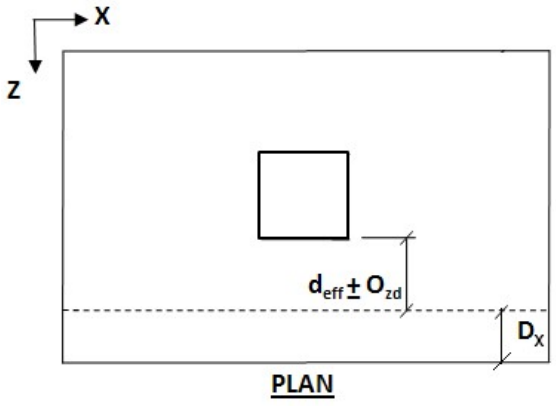
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 393.700096 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 56.460 kN

Shear Stress(T_v) = 124.470579 kN/m2

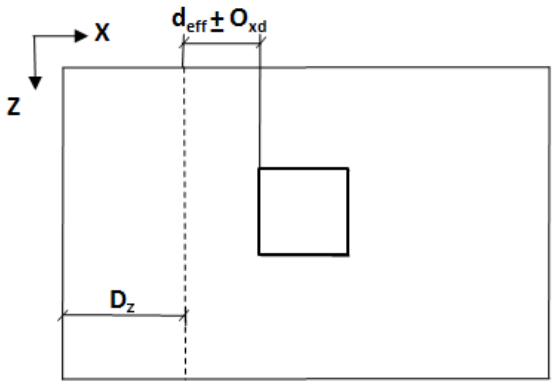
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 69.271 kN

Shear Stress(T_v) = 152.713017 kN/m2

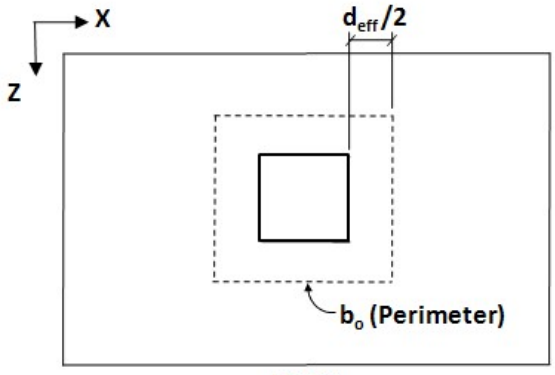
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 203.662 kN

Shear Stress(T_v) = 309.885 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

K_s x T_c = 1250.0000 kN/m2

$T_v <= K_s$ x T_c hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.675 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

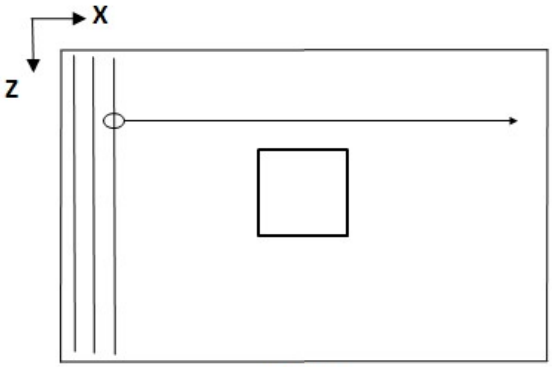
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.484 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.625 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 338.221 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 73.652 mm

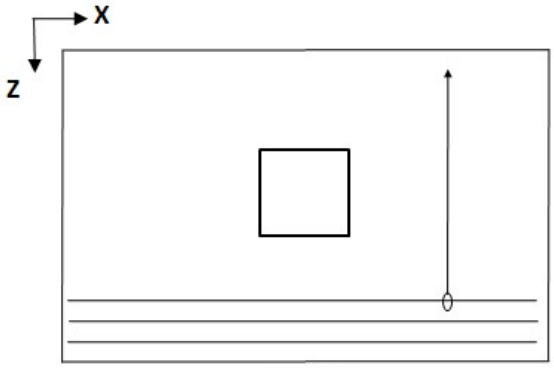
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 429.452 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.652 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

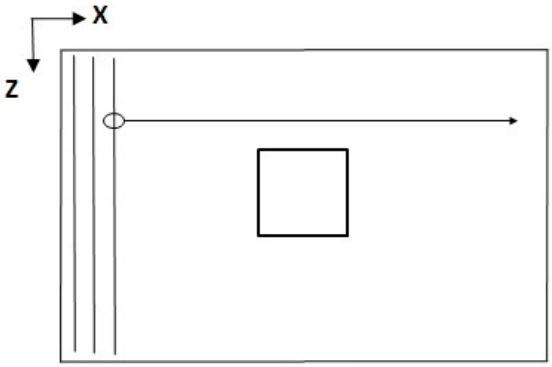
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 658.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 3.474 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 73.652 mm

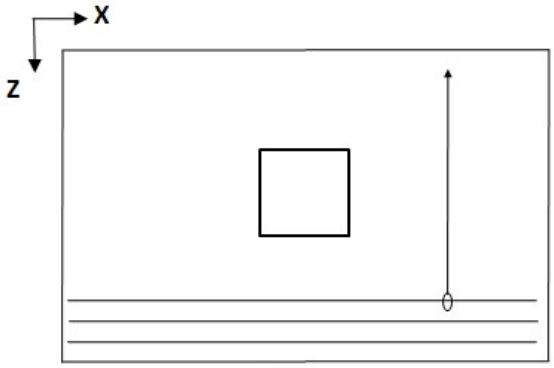
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 658.800 mm2

Calculated Area of Steel (A_{st}) = 658.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 658.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.008 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 73.652 mm

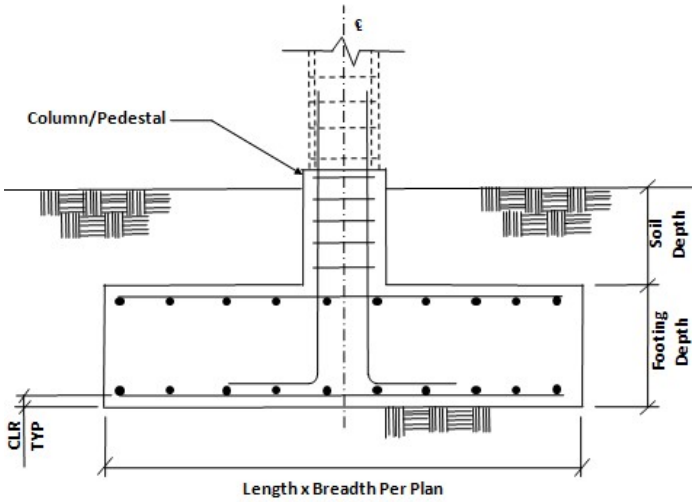
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

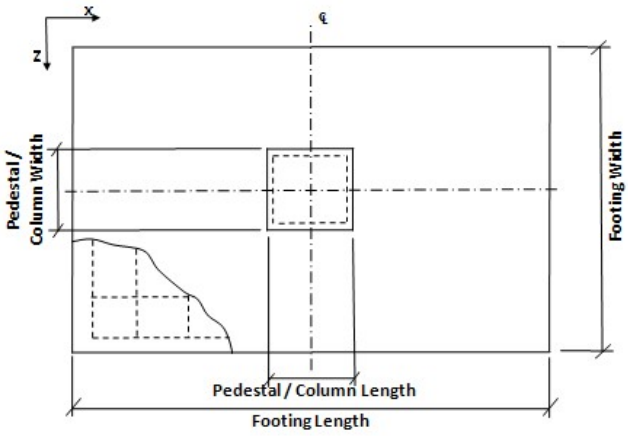
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 44



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal? No
Pedestal Shape : N/A
Pedestal Height (Ph) : N/A
Pedestal Length - X (Pl) : N/A
Pedestal Width - Z (Pw) : N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3
Strength of Concrete : 25.000 N/mm2
Yield Strength of Steel : 415.000 N/mm2
Minimum Bar Size : Ø6
Maximum Bar Size : Ø32
Minimum Bar Spacing : 50.000 mm
Maximum Bar Spacing : 500.000 mm
Pedestal Clear Cover (P, CL) : 50.000 mm
Footing Clear Cover (F, CL) : 50.000 mm

Soil Properties

Soil Type : Drained
Unit Weight : 22.000 kN/m3
Soil Bearing Capacity : 100.000 kN/m2
Soil Surcharge : 0.000 kN/m2
Depth of Soil above Footing : 0.000 mm
Cohesion : 0.000 kN/m2
Min Percentage of Slab : 0.000

Sliding and Overturning

Coefficient of Friction : 0.500
Factor of Safety Against Sliding : 1.500
Factor of Safety Against Overturning : 1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1124.187	-1.923	0.953	0.914	1.963
2	141.831	-5.712	3.134	3.022	5.874
4	35.458	-1.428	0.784	0.756	1.468
5	0.011	-0.021	-0.019	-0.016	0.028
6	0.016	-0.001	0.025	0.022	0.015

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1124.187	-1.923	0.953	0.914	1.963
2	141.831	-5.712	3.134	3.022	5.874
4	35.458	-1.428	0.784	0.756	1.468
5	0.011	-0.021	-0.019	-0.016	0.028
6	0.016	-0.001	0.025	0.022	0.015

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 11.318 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

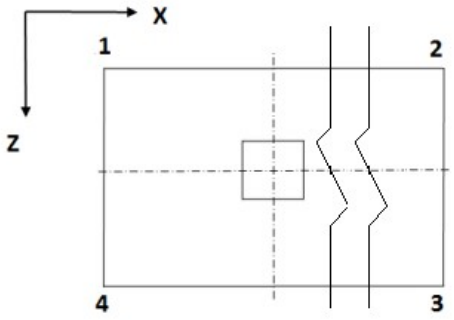
Length (L_2) = 3.500 m Governing Load Case : # 1

Width (W_2) = 3.500 m Governing Load Case : # 1

Depth (D_2) = 0.406 m Governing Load Case : # 1

Area (A_2) = 12.250 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
1	**99.5836**	98.8701	99.2072	99.9207	0.000
1	99.5836	**98.8701**	99.2072	99.9207	0.000
1	99.5836	98.8701	**99.2072**	99.9207	0.000
1	99.5836	98.8701	99.2072	**99.9207**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
1	**99.5836**	98.8701	99.2072	99.9207
1	99.5836	**98.8701**	99.2072	99.9207
1	99.5836	98.8701	**99.2072**	99.9207
1	99.5836	98.8701	99.2072	**99.9207**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	316.553	639.096	1769.158	835.861
2	20.591	37.526	103.483	54.054
4	45.120	82.227	226.754	118.444
5	2272.599	2417.636	7333.729	4779.761
6	43250.878	1904.937	5609.499	10818.874

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -5.712 kN
Governing Restoring Force : 117.619 kN
Minimum Sliding Ratio for the Critical Load Case : 20.591
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 3.978 kNm
Governing Resisting Moment : 411.657 kNm
Minimum Overturning Ratio for the Critical Load Case : 103.483

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 3.134 kN
Governing Restoring Force : 117.619 kN
Minimum Sliding Ratio for the Critical Load Case : 37.526
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 7.616 kNm
Governing Resisting Moment : 411.657 kNm
Minimum Overturning Ratio for the Critical Load Case : 54.054

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 373.971 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 399.460 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

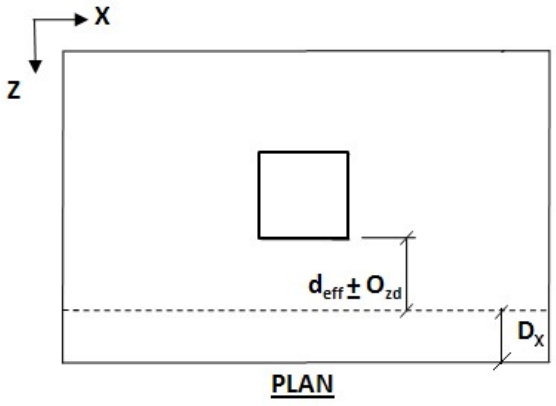
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #1

D_X = 0.352 m

Shear Force(S) = 377.223 kN

Shear Stress(T_v) = 306.187772 kN/m2

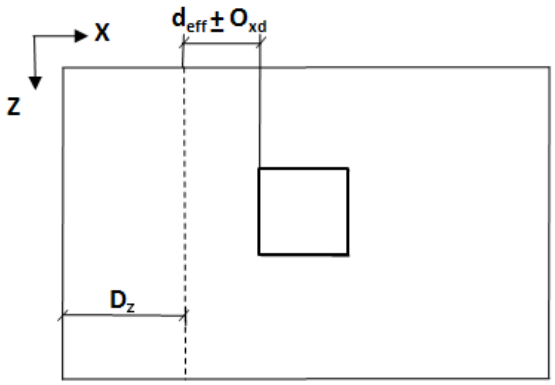
Percentage Of Steel(P_t) = 0.2670

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 375.288 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #1

D_Z = 0.352 m

Shear Force(S) = 393.817 kN

Shear Stress(T_v) = 319.656277 kN/m2

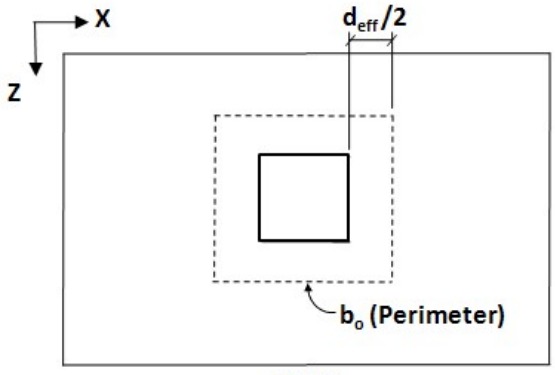
Percentage Of Steel(P_t) = 0.2492

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 364.214 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #1

Shear Force(S) = 1072.520 kN

Shear Stress(T_v) = 1012.943 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 1.525 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

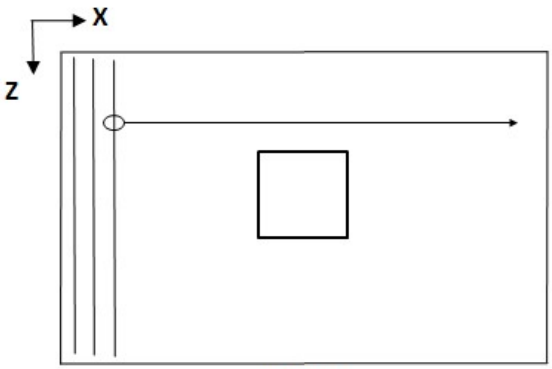
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 1.475 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3069.591 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3069.591 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = 48.000 mm

Selected spacing (S) = 55.607 mm

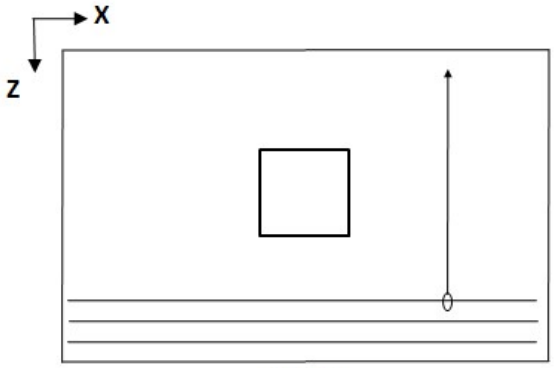
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 55.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3288.947 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3288.947 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 52.185 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

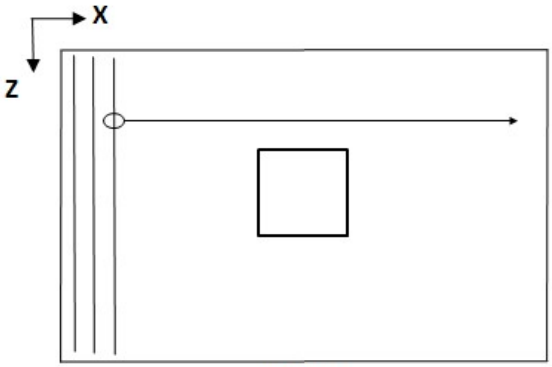
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 34.480 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 75.422 mm

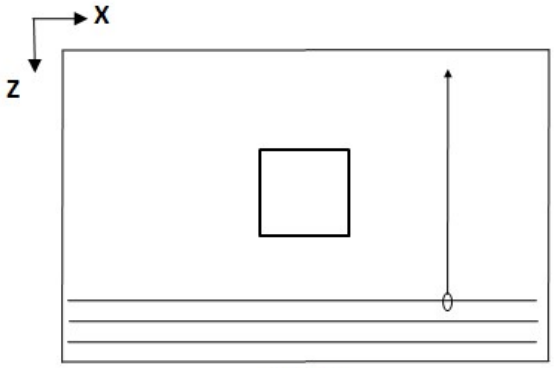
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 36.778 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 75.422 mm

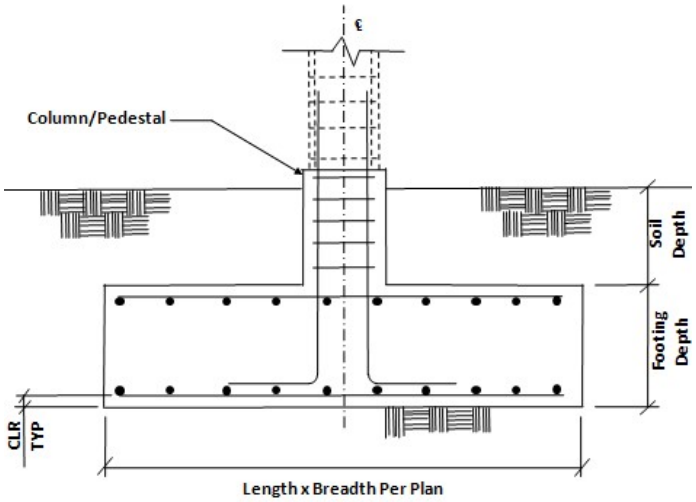
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

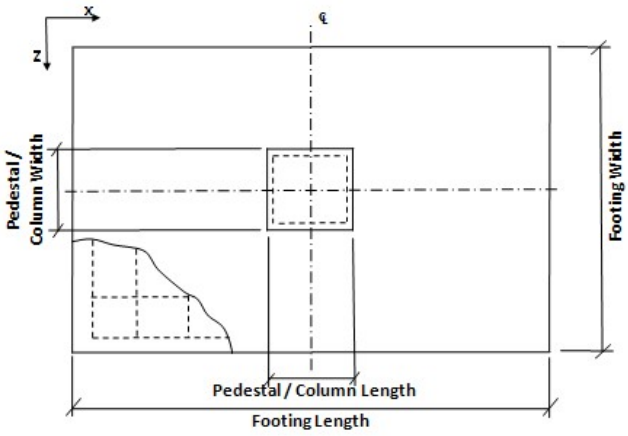
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Isolated Footing 45



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.114	0.550	1.551	1.528	-0.473
2	290.751	0.032	6.770	6.676	0.226
4	72.688	0.008	1.692	1.669	0.056
5	0.005	-0.011	-0.000	-0.000	0.019
6	-0.020	-0.008	0.077	0.067	0.021

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.114	0.550	1.551	1.528	-0.473
2	290.751	0.032	6.770	6.676	0.226
4	72.688	0.008	1.692	1.669	0.056
5	0.005	-0.011	-0.000	-0.000	0.019
6	-0.020	-0.008	0.077	0.067	0.021

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 2.984 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

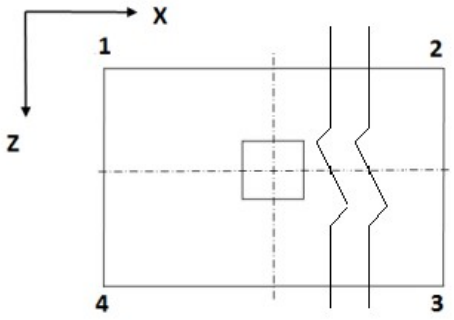
Length (L_2) = 1.900 m Governing Load Case : # 2

Width (W_2) = 1.900 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.610 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**80.7086**	80.3304	95.6224	96.0005	0.000
2	80.7086	**80.3304**	95.6224	96.0005	0.000
2	80.7086	80.3304	**95.6224**	96.0005	0.000
2	80.7086	80.3304	95.6224	**96.0005**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**80.7086**	80.3304	95.6224	96.0005
2	80.7086	**80.3304**	95.6224	96.0005
2	80.7086	80.3304	**95.6224**	96.0005
2	80.7086	80.3304	95.6224	**96.0005**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	185.211	65.647	96.663	302.094
2	5040.980	23.508	34.593	1398.837
4	6349.090	29.607	43.568	1761.787
5	1248.120	60641.051	86824.191	1152.950
6	1628.733	178.247	287.499	1094.508

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 1
Governing Disturbing Force : 0.550 kN
Governing Restoring Force : 101.820 kN
Minimum Sliding Ratio for the Critical Load Case : 185.211
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 8.740 kNm
Governing Resisting Moment : 302.358 kNm
Minimum Overturning Ratio for the Critical Load Case : 34.593

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 6.770 kN
Governing Restoring Force : 159.139 kN
Minimum Sliding Ratio for the Critical Load Case : 23.508
Critical Load Case for Overturning about Z-Direction : 1
Governing Overturning Moment : -0.640 kNm
Governing Resisting Moment : 193.455 kNm
Minimum Overturning Ratio for the Critical Load Case : 302.094

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 43.067 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 46.034 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

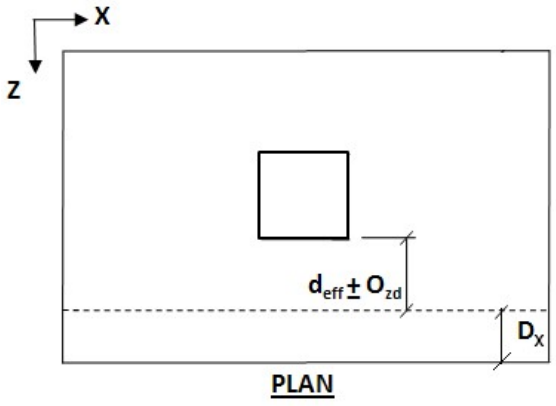
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 77.543 kN

Shear Stress(T_v) = 161.951812 kN/m2

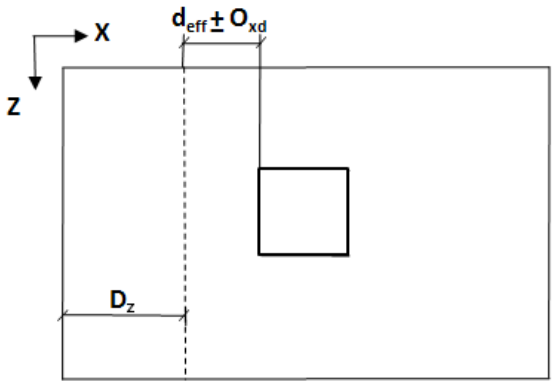
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 80.169 kN

Shear Stress(T_v) = 167.437847 kN/m2

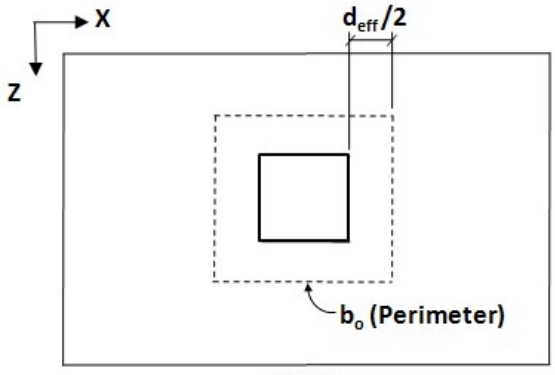
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 256.714 kN

Shear Stress(T_v) = 390.609 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.725 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

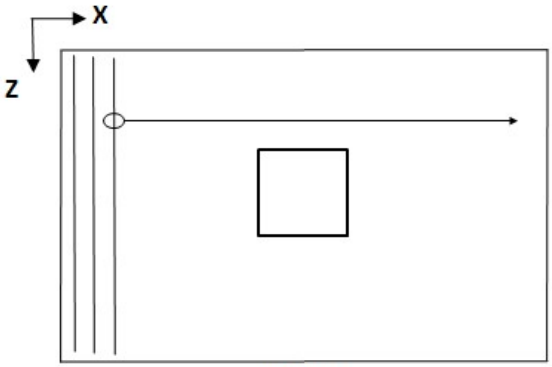
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.675 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 481.382 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 74.750 mm

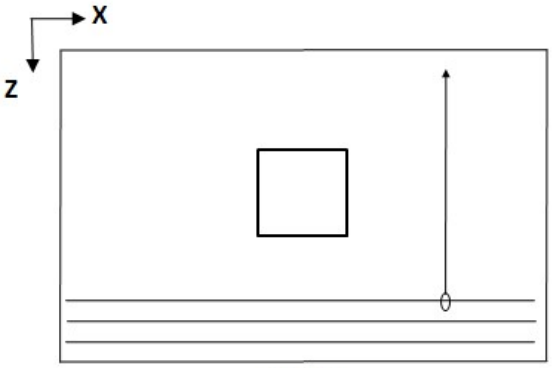
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 515.159 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

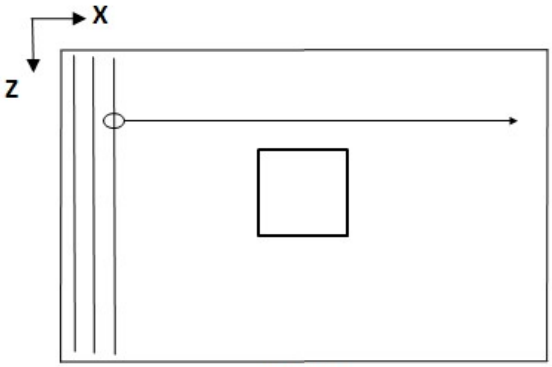
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.230 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.750 mm

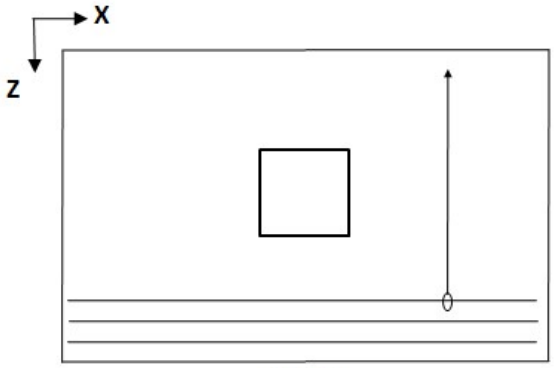
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.834 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

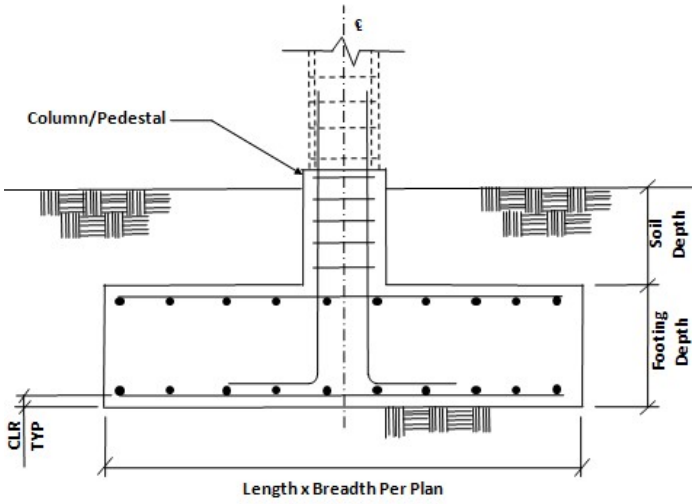
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

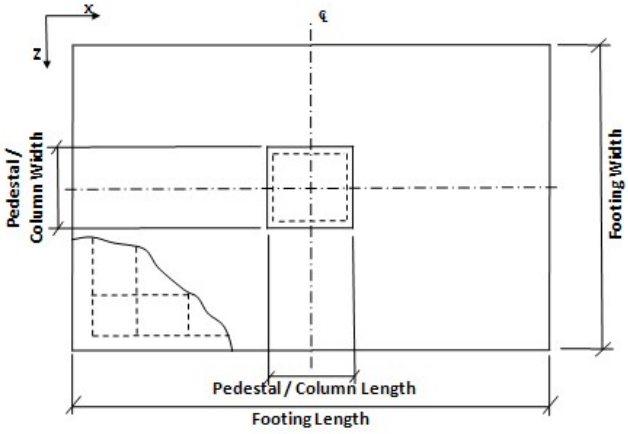
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 46



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.174	-0.668	1.551	1.528	0.729
2	290.811	-0.461	6.770	6.676	0.699
4	72.703	-0.115	1.693	1.669	0.175
5	0.004	-0.003	-0.000	-0.000	0.013
6	-0.021	-0.014	0.077	0.067	0.026

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	176.174	-0.668	1.551	1.528	0.729
2	290.811	-0.461	6.770	6.676	0.699
4	72.703	-0.115	1.693	1.669	0.175
5	0.004	-0.003	-0.000	-0.000	0.013
6	-0.021	-0.014	0.077	0.067	0.026

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 2.984 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

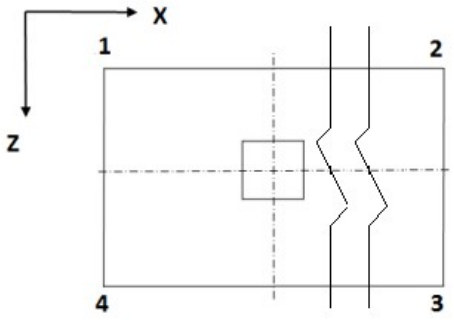
Length (L_2) = 1.900 m Governing Load Case : # 2

Width (W_2) = 1.900 m Governing Load Case : # 2

Depth (D_2) = 0.305 m Governing Load Case : # 2

Area (A_2) = 3.610 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**81.2696**	79.8008	95.0945	96.5633	0.000
2	81.2696	**79.8008**	95.0945	96.5633	0.000
2	81.2696	79.8008	**95.0945**	96.5633	0.000
2	81.2696	79.8008	95.0945	**96.5633**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**81.2696**	79.8008	95.0945	96.5633
2	81.2696	**79.8008**	95.0945	96.5633
2	81.2696	79.8008	**95.0945**	96.5633
2	81.2696	79.8008	95.0945	**96.5633**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	152.361	65.688	96.726	207.481
2	345.205	23.509	34.595	360.226
4	434.754	29.608	43.570	453.670
5	4045.039	72448.775	109913.878	1888.797
6	966.397	178.314	288.935	858.576

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 1
Governing Disturbing Force : -0.668 kN
Governing Restoring Force : 101.850 kN
Minimum Sliding Ratio for the Critical Load Case : 152.361
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 8.741 kNm
Governing Resisting Moment : 302.415 kNm
Minimum Overturning Ratio for the Critical Load Case : 34.595

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 6.770 kN
Governing Restoring Force : 159.169 kN
Minimum Sliding Ratio for the Critical Load Case : 23.509
Critical Load Case for Overturning about Z-Direction : 1
Governing Overturning Moment : 0.933 kNm
Governing Resisting Moment : 193.512 kNm
Minimum Overturning Ratio for the Critical Load Case : 207.481

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 43.075 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #2

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 46.270 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

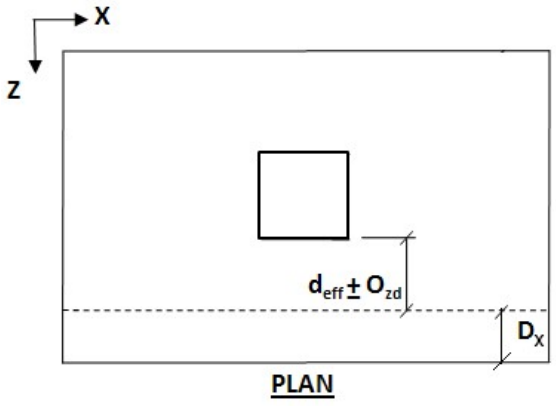
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 415.572323 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #2

D_X = 0.252 m

Shear Force(S) = 77.558 kN

Shear Stress(T_v) = 161.984176 kN/m2

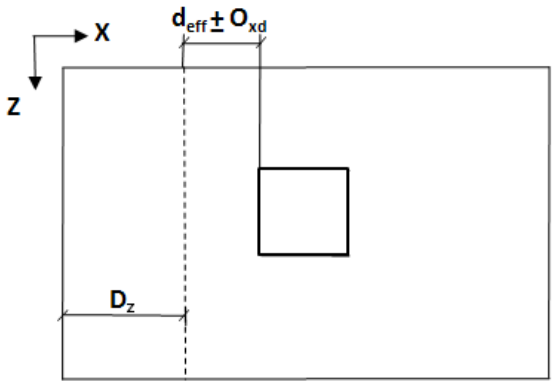
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #2

D_Z = 0.252 m

Shear Force(S) = 80.578 kN

Shear Stress(T_v) = 168.292475 kN/m2

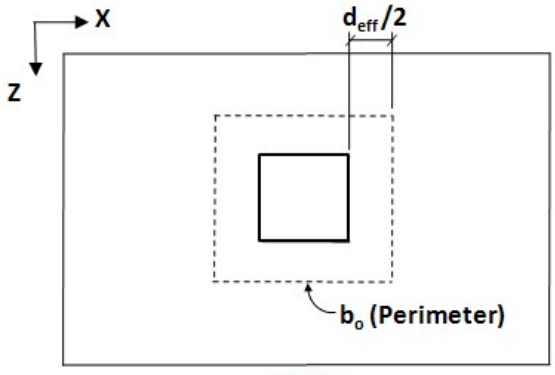
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #2

Shear Force(S) = 256.767 kN

Shear Stress(T_v) = 390.689 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

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

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.725 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

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

As Per IS 456 2000 Clause 26.2.1

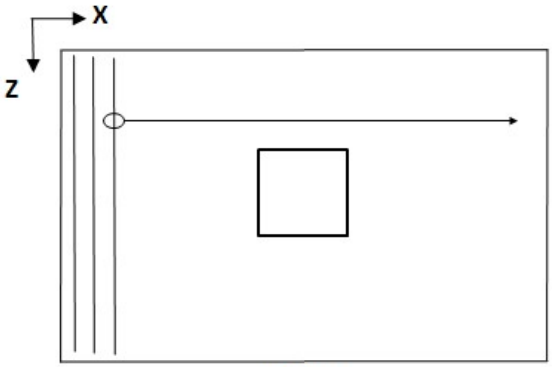
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.645 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.675 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 481.480 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 74.750 mm

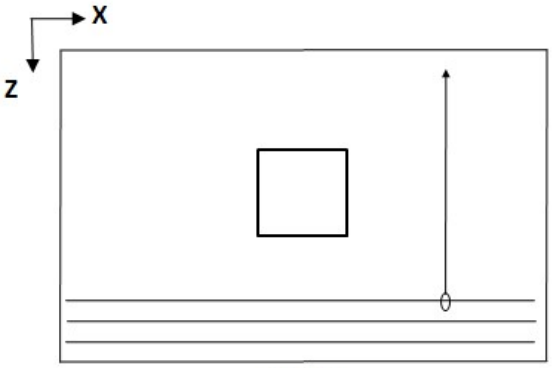
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #2

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 517.849 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

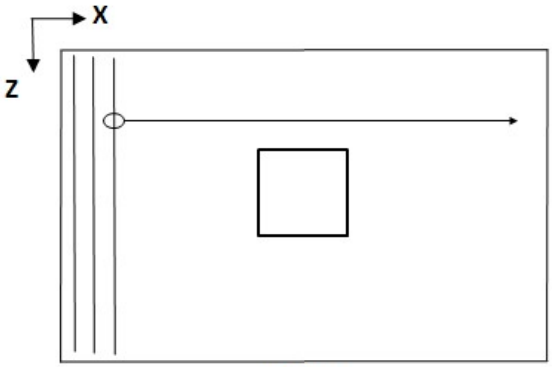
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.230 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.750 mm

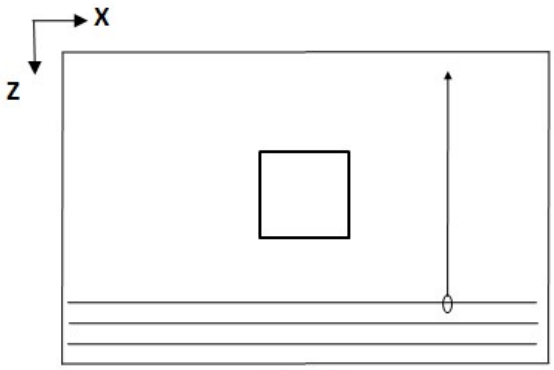
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 695.400 mm2

Calculated Area of Steel (A_{st}) = 695.400 mm2

Provided Area of Steel ($A_{st,Provided}$) = 695.400 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 4.834 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.750 mm

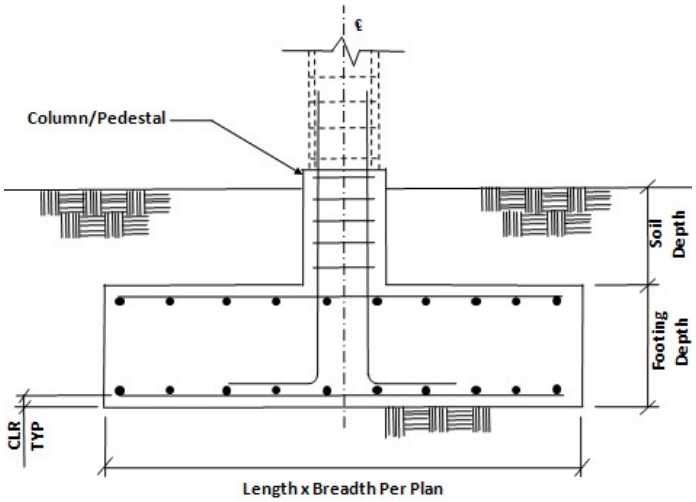
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

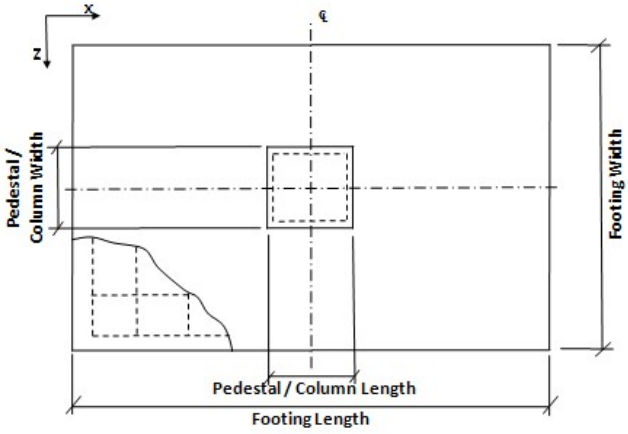
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 47



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1123.359	1.823	0.899	0.861	-1.725
2	140.963	5.327	3.098	2.984	-4.993
4	35.241	1.332	0.774	0.746	-1.248
5	-0.011	0.006	-0.021	-0.018	0.004
6	-0.017	-0.022	0.022	0.019	0.033

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	1123.359	1.823	0.899	0.861	-1.725
2	140.963	5.327	3.098	2.984	-4.993
4	35.241	1.332	0.774	0.746	-1.248
5	-0.011	0.006	-0.021	-0.018	0.004
6	-0.017	-0.022	0.022	0.019	0.033

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 11.310 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

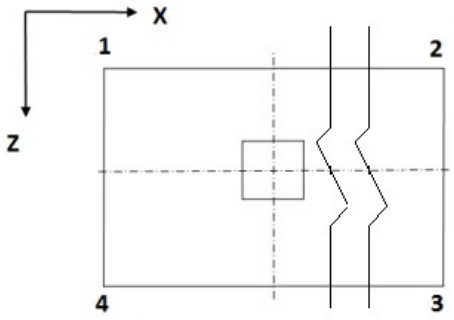
Length (L_2) = 3.500 m Governing Load Case : # 1

Width (W_2) = 3.500 m Governing Load Case : # 1

Depth (D_2) = 0.406 m Governing Load Case : # 1

Area (A_2) = 12.250 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
1	**98.8498**	99.4881	99.8058	99.1674	0.000
1	98.8498	**99.4881**	99.8058	99.1674	0.000
1	98.8498	99.4881	**99.8058**	99.1674	0.000
1	98.8498	99.4881	99.8058	**99.1674**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
1	**98.8498**	99.4881	99.8058	99.1674
1	98.8498	**99.4881**	99.8058	99.1674
1	98.8498	99.4881	**99.8058**	99.1674
1	98.8498	99.4881	99.8058	**99.1674**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	333.745	676.535	1876.225	933.629
2	21.998	37.831	104.388	61.977
4	48.299	83.063	229.196	136.078
5	7866.826	2207.605	6615.266	64031.297
6	2137.349	2150.242	6400.943	4125.248

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : 5.327 kN
Governing Restoring Force : 117.185 kN
Minimum Sliding Ratio for the Critical Load Case : 21.998
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 3.929 kNm
Governing Resisting Moment : 410.139 kNm
Minimum Overturning Ratio for the Critical Load Case : 104.388

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 3.098 kN
Governing Restoring Force : 117.185 kN
Minimum Sliding Ratio for the Critical Load Case : 37.831
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : -6.618 kNm
Governing Resisting Moment : 410.139 kNm
Minimum Overturning Ratio for the Critical Load Case : 61.977

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 373.668 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.352 m

Governing moment (M_u) = 399.053 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

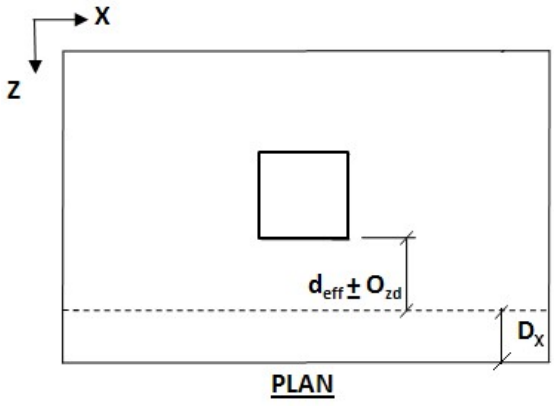
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 1493.637811 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #1

D_X = 0.352 m

Shear Force(S) = 376.919 kN

Shear Stress(T_v) = 305.940913 kN/m2

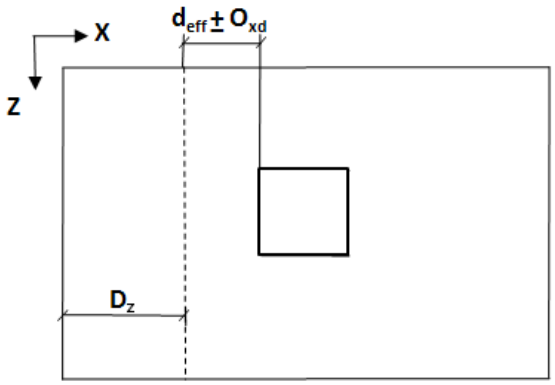
Percentage Of Steel(P_t) = 0.2667

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 375.114 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #1

D_Z = 0.352 m

Shear Force(S) = 393.422 kN

Shear Stress(T_v) = 319.336431 kN/m2

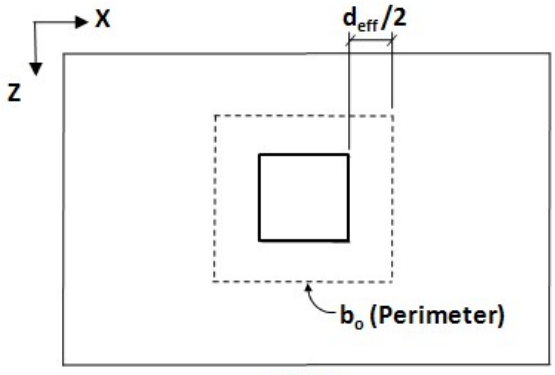
Percentage Of Steel(P_t) = 0.2489

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 364.080 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #1

Shear Force(S) = 1071.730 kN

Shear Stress(T_v) = 1012.196 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 1.525 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 32 mm

As Per IS 456 2000 Clause 26.2.1

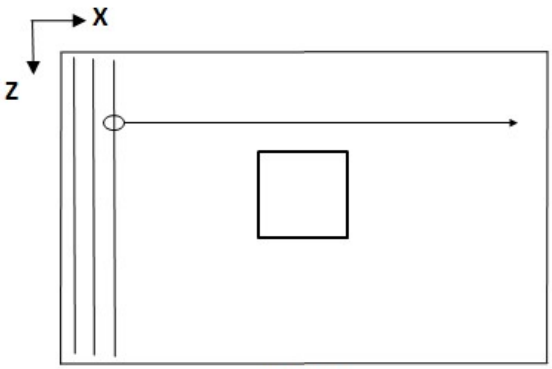
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 1.289 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 1.475 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3066.990 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3066.990 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = 48.000 mm

Selected spacing (S) = 55.607 mm

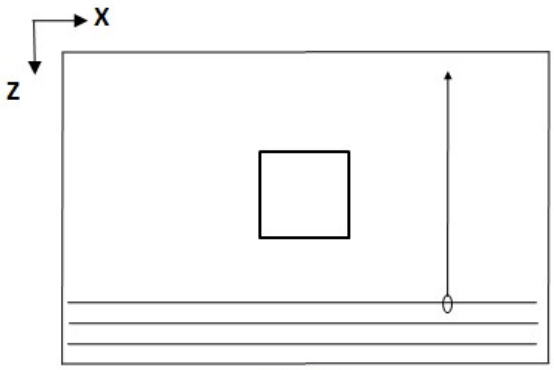
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 55.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 3285.435 mm2

Provided Area of Steel ($A_{st,Provided}$) = 3285.435 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø8

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 52.185 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

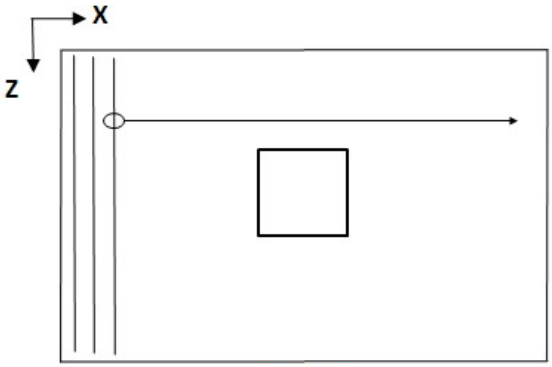
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø8 @ 50.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 34.480 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 75.422 mm

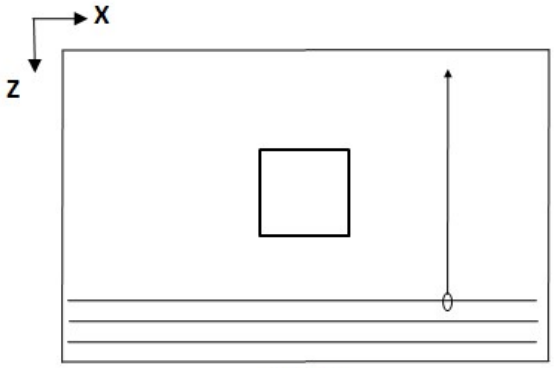
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 1705.200 mm2

Calculated Area of Steel (A_{st}) = 1281.000 mm2

Provided Area of Steel ($A_{st,Provided}$) = 1705.200 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 36.778 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 75.422 mm

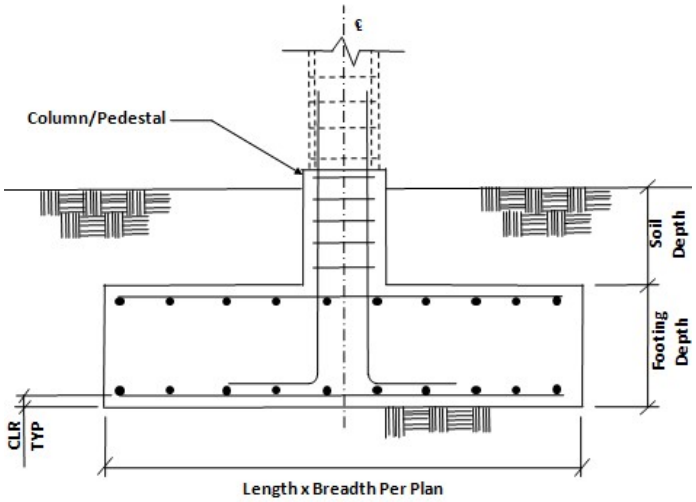
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

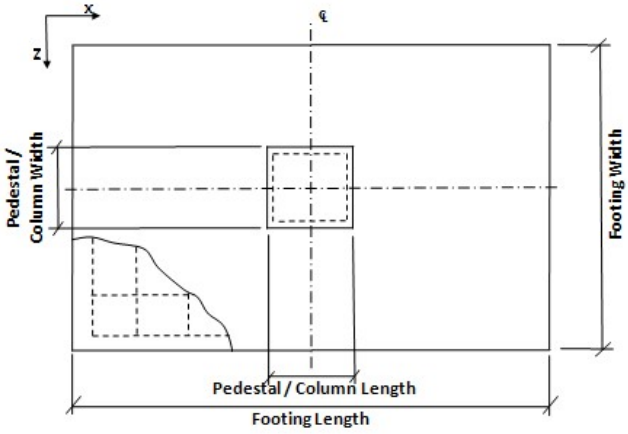
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 75 mm o.c.

Isolated Footing 173



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level

Load Combination Number	Load Combination Title
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	142.693	-0.555	-0.559	-0.542	0.673
2	55.963	-1.013	-1.080	-1.049	1.462
4	13.991	-0.253	-0.270	-0.262	0.365
5	-0.088	-0.030	0.005	0.004	0.023
6	-0.027	0.013	-0.005	-0.004	-0.022

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	142.693	-0.555	-0.559	-0.542	0.673
2	55.963	-1.013	-1.080	-1.049	1.462
4	13.991	-0.253	-0.270	-0.262	0.365
5	-0.088	-0.030	0.005	0.004	0.023
6	-0.027	0.013	-0.005	-0.004	-0.022

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 1.503 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

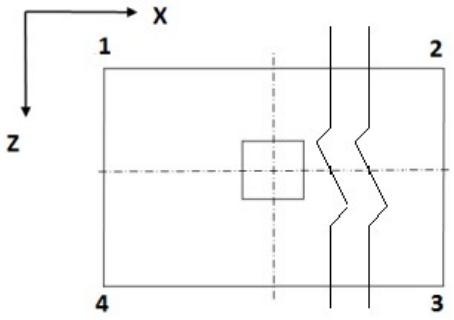
Length (L_2) = 1.300 m Governing Load Case : # 1

Width (W_2) = 1.300 m Governing Load Case : # 1

Depth (D_2) = 0.305 m Governing Load Case : # 1

Area (A_2) = 1.690 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
1	**96.3044**	91.7057	87.8130	92.4117	0.000
1	96.3044	**91.7057**	87.8130	92.4117	0.000
1	96.3044	91.7057	**87.8130**	92.4117	0.000
1	96.3044	91.7057	87.8130	**92.4117**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
1	**96.3044**	91.7057	87.8130	92.4117
1	96.3044	**91.7057**	87.8130	92.4117
1	96.3044	91.7057	**87.8130**	92.4117
1	96.3044	91.7057	87.8130	**92.4117**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 1.690 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	140.248	139.106	141.894	120.110
2	33.967	31.860	32.467	25.269
4	53.040	49.750	50.697	39.457
5	214.229	1318.026	1496.233	256.589
6	491.414	1400.491	1505.163	317.434

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -1.013 kN
Governing Restoring Force : 34.424 kN
Minimum Sliding Ratio for the Critical Load Case : 33.967
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : -1.378 kNm
Governing Resisting Moment : 44.751 kNm
Minimum Overturning Ratio for the Critical Load Case : 32.467

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : -1.080 kN
Governing Restoring Force : 34.424 kN
Minimum Sliding Ratio for the Critical Load Case : 31.860
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 1.771 kNm
Governing Resisting Moment : 44.751 kNm
Minimum Overturning Ratio for the Critical Load Case : 25.269

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 10.092 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 284.338958 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 12.638 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

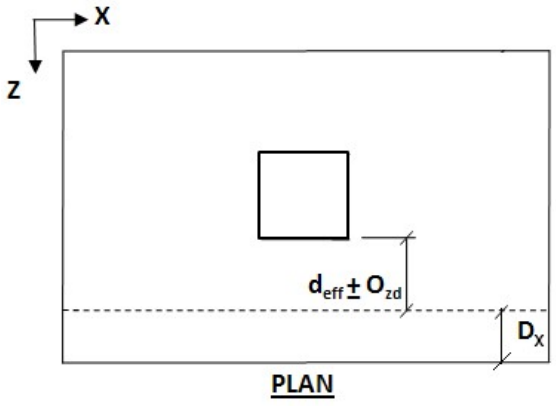
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 284.338958 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



PLAN

Critical Load Case = #1

D_X = 0.252 m

Shear Force(S) = 19.369 kN

Shear Stress(T_v) = 59.122751 kN/m2

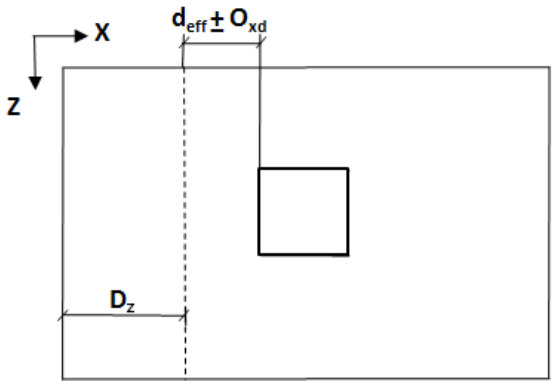
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #1

D_Z = 0.252 m

Shear Force(S) = 25.030 kN

Shear Stress(T_v) = 76.402807 kN/m2

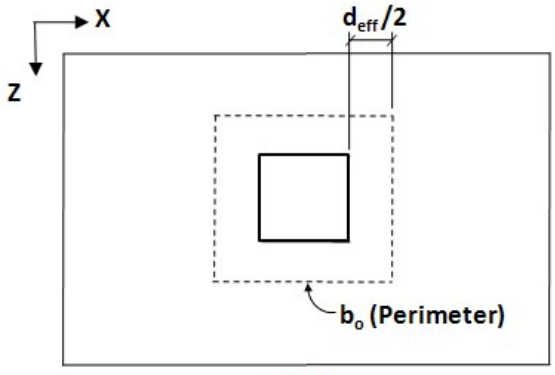
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #1

Shear Force(S) = 107.011 kN

Shear Stress(T_v) = 162.825 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.403 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.425 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 10 mm

As Per IS 456 2000 Clause 26.2.1

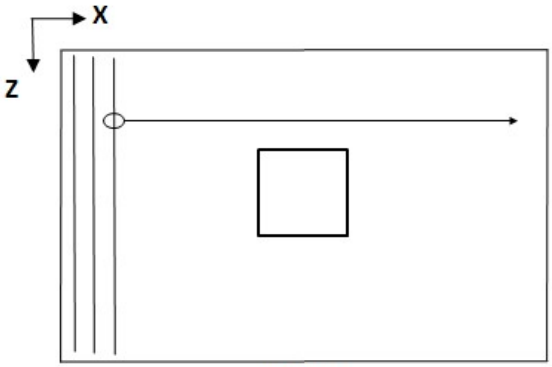
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.322 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.375 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



PLAN

For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 111.547 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 74.625 mm

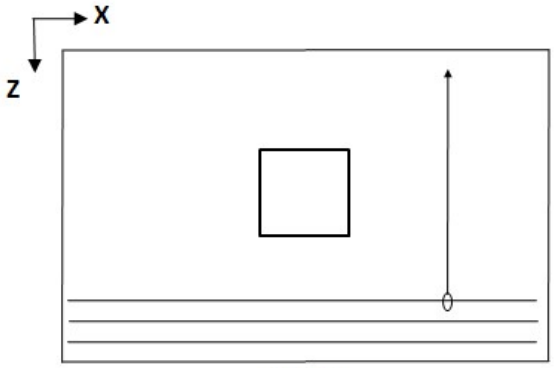
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 139.891 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.625 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

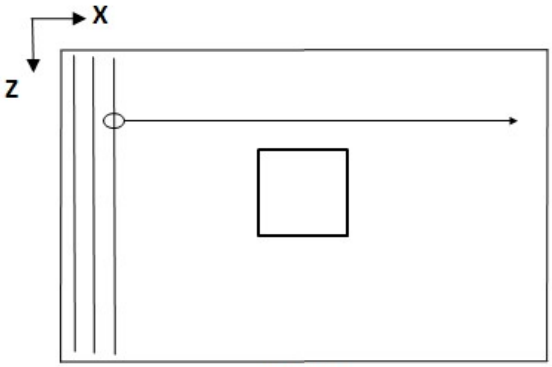
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 475.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 0.995 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.625 mm

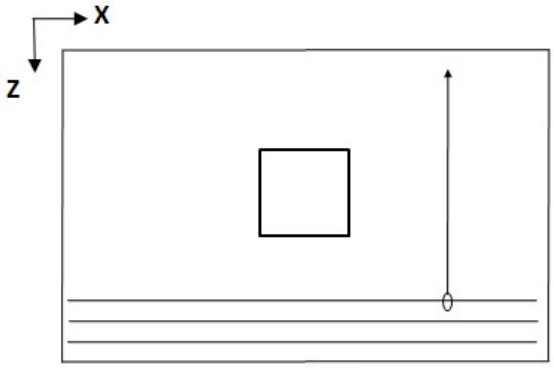
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 475.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin}<= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 1.242 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.625 mm

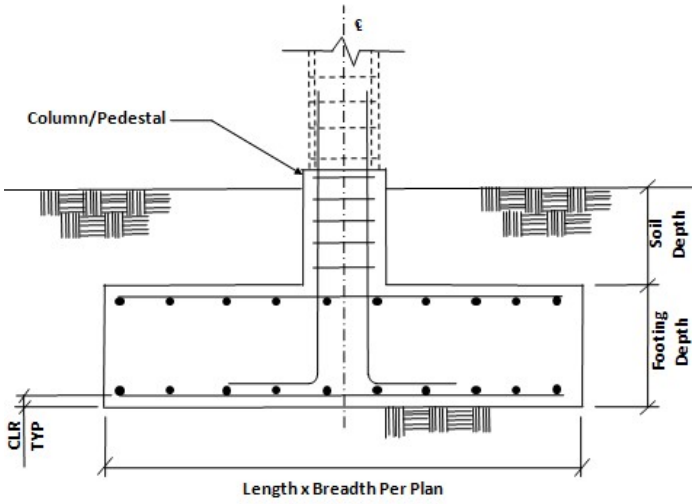
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

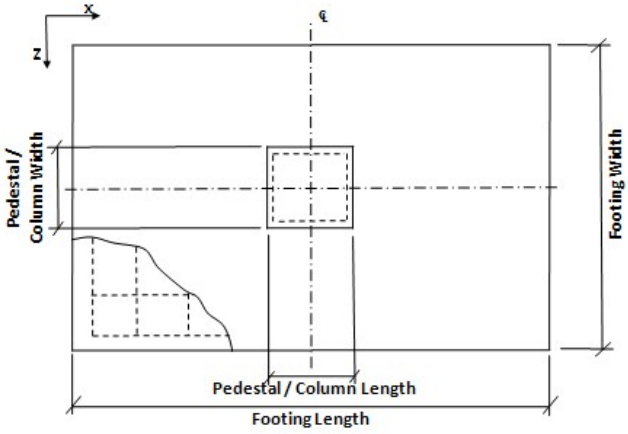
Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Isolated Footing 174



ELEVATION



PLAN

Input Values

Footing Geomtery

Design Type :	Calculate Dimension
Footing Thickness (Ft) :	305.000 mm
Footing Length - X (Fl) :	1000.000 mm
Footing Width - Z (Fw) :	1000.000 mm
Eccentricity along X (Oxd) :	0.000 mm
Eccentricity along Z (Ozd) :	0.000 mm

Column Dimensions

Column Shape :	Rectangular
Column Length - X (Pl) :	0.350 m
Column Width - Z (Pw) :	0.450 m

Pedestal

Include Pedestal?	No
Pedestal Shape :	N/A
Pedestal Height (Ph) :	N/A
Pedestal Length - X (Pl) :	N/A
Pedestal Width - Z (Pw) :	N/A

Design Parameters

Concrete and Rebar Properties

Unit Weight of Concrete :	25.000 kN/m3
Strength of Concrete :	25.000 N/mm2
Yield Strength of Steel :	415.000 N/mm2
Minimum Bar Size :	Ø6
Maximum Bar Size :	Ø32
Minimum Bar Spacing :	50.000 mm
Maximum Bar Spacing :	500.000 mm
Pedestal Clear Cover (P, CL) :	50.000 mm
Footing Clear Cover (F, CL) :	50.000 mm

Soil Properties

Soil Type :	Drained
Unit Weight :	22.000 kN/m3
Soil Bearing Capacity :	100.000 kN/m2
Soil Surcharge :	0.000 kN/m2
Depth of Soil above Footing :	0.000 mm
Cohesion :	0.000 kN/m2
Min Percentage of Slab :	0.000

Sliding and Overturning

Coefficient of Friction :	0.500
Factor of Safety Against Sliding :	1.500
Factor of Safety Against Overturning :	1.500

Load Combination/s- Service Stress Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X

6	W Z

Load Combination/s- Strength Level	
Load Combination Number	**Load Combination Title**
1	DL
2	LL
4	FLOOR FINISH
5	W X
6	W Z

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	142.693	-0.555	0.559	0.542	0.673
2	55.963	-1.013	1.080	1.049	1.462
4	13.991	-0.253	0.270	0.262	0.365
5	-0.088	-0.030	-0.005	-0.004	0.023
6	-0.027	0.013	0.005	0.004	-0.022

Applied Loads - Strength Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	142.693	-0.555	0.559	0.542	0.673
2	55.963	-1.013	1.080	1.049	1.462
4	13.991	-0.253	0.270	0.262	0.365
5	-0.088	-0.030	-0.005	-0.004	0.023
6	-0.027	0.013	0.005	0.004	-0.022

Design Calculations

Footing Size

Initial Length (L_o) = 1.000 m

Initial Width (W_o) = 1.000 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, $A_o = L_o \times W_o$ = 1.000 m^2

Min. area required from bearing pressure, $A_{min} = P / q_{max}$ = 1.503 m^2

Note: A_{min} is an initial estimation.
P = Critical Factored Axial Load(without self weight/buoyancy/soil).
q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

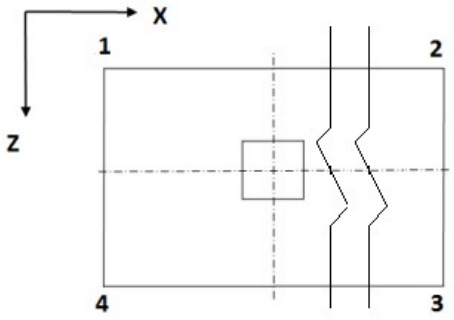
Length (L_2) = 1.300 m Governing Load Case : # 1

Width (W_2) = 1.300 m Governing Load Case : # 1

Depth (D_2) = 0.305 m Governing Load Case : # 1

Area (A_2) = 1.690 m^2

Pressures at Four Corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
1	**92.4117**	87.8130	91.7057	96.3044	0.000
1	92.4117	**87.8130**	91.7057	96.3044	0.000
1	92.4117	87.8130	**91.7057**	96.3044	0.000
1	92.4117	87.8130	91.7057	**96.3044**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
1	**92.4117**	87.8130	91.7057	96.3044
1	92.4117	**87.8130**	91.7057	96.3044
1	92.4117	87.8130	**91.7057**	96.3044
1	92.4117	87.8130	91.7057	**96.3044**

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 1.690 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

-	Factor of safety against sliding		Factor of safety against overturning	
Load Case No.	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
1	140.248	139.106	141.894	120.110
2	33.967	31.860	32.467	25.269
4	53.040	49.750	50.697	39.457
5	214.229	1318.026	1496.233	256.589
6	491.414	1400.491	1505.163	317.434

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2
Governing Disturbing Force : -1.013 kN
Governing Restoring Force : 34.424 kN
Minimum Sliding Ratio for the Critical Load Case : 33.967
Critical Load Case for Overturning about X-Direction : 2
Governing Overturning Moment : 1.378 kNm
Governing Resisting Moment : 44.751 kNm
Minimum Overturning Ratio for the Critical Load Case : 32.467

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

Critical Load Case for Sliding along Z-Direction : 2
Governing Disturbing Force : 1.080 kN
Governing Restoring Force : 34.424 kN
Minimum Sliding Ratio for the Critical Load Case : 31.860
Critical Load Case for Overturning about Z-Direction : 2
Governing Overturning Moment : 1.771 kNm
Governing Resisting Moment : 44.751 kNm
Minimum Overturning Ratio for the Critical Load Case : 25.269

Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 10.092 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 284.338958 kNm

M_u <= M_{umax} hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

Critical Load Case = #1

Effective Depth = $D - (cc + 0.5 \times d_b)$ = 0.252 m

Governing moment (M_u) = 12.638 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (K_{umax}) = $\frac{700}{(1100 + 0.87 \times f_y)}$ = 0.479107

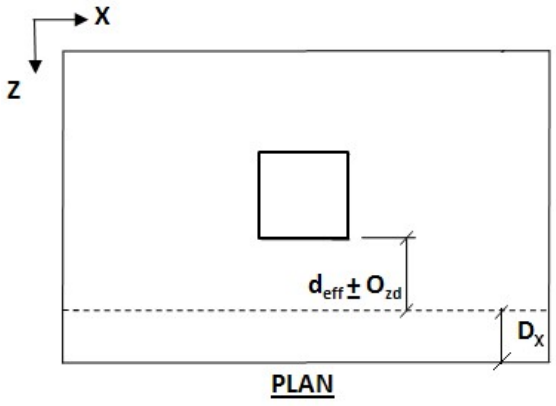
Limiting Factor2 (R_{umax}) = $0.36 \times f_{ck} \times k_{umax} \times (1 - 0.42 \times kumax)$ = 3444.291146 kN/m2

Limit Moment Of Resistance (M_{umax}) = $R_{umax} \times B \times d_e^2$ = 284.338958 kNm

M_u <= M_{umax} hence, safe

Shear Calculation

Check Trial Depth for one way shear (Along X Axis)
(Shear Plane Parallel to X Axis)



Critical Load Case = #1

D_X = 0.252 m

Shear Force(S) = 19.369 kN

Shear Stress(T_v) = 59.122751 kN/m2

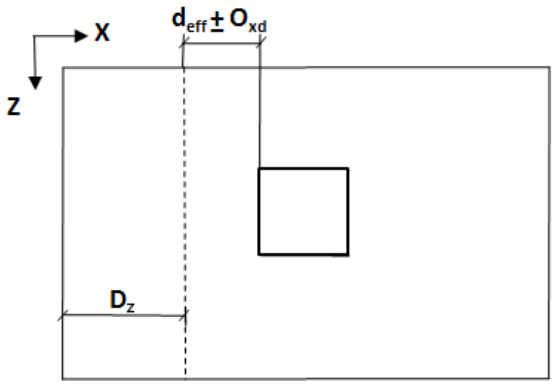
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for one way shear (Along Z Axis)
(Shear Plane Parallel to Z Axis)



PLAN

Critical Load Case = #1

D_Z = 0.252 m

Shear Force(S) = 25.030 kN

Shear Stress(T_v) = 76.402807 kN/m2

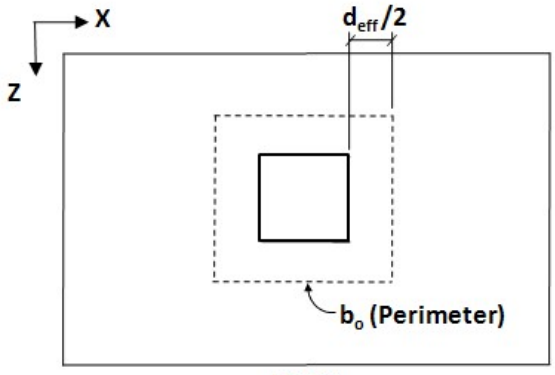
Percentage Of Steel(P_t) = 0.1452

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(T_c) = 286.768 kN/m2

$T_v < T_c$ hence, safe

Check Trial Depth for two way shear



PLAN

Critical Load Case = #1

Shear Force(S) = 107.011 kN

Shear Stress(T_v) = 162.825 kN/m2

As Per IS 456 2000 Clause 31.6.3.1

$K_s = \min[(0.5 + \beta), 1] = 1.000$

Shear Strength(T_c)= $0.25 \times \sqrt{f_{ck}}$ = 1250.0000 kN/m2

$K_s \times T_c$ = 1250.0000 kN/m2

$T_v <= K_s \times T_c$ hence, safe

Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (d_b) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.403 m

Allowable Length(l_{db}) = $\left[\frac{(B - b)}{2} - cc\right]$ = 0.425 m

$l_{db} >= l_d$ hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(d_b) = 10 mm

As Per IS 456 2000 Clause 26.2.1

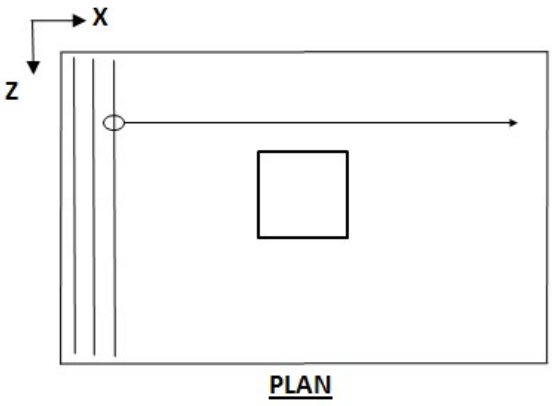
Development Length(l_d) = $\frac{d_b \times 0.87 \times f_y}{4 \times \tau_{bd}}$ = 0.322 m

Allowable Length(l_{db}) = $\left[\frac{(H - h)}{2} - cc\right]$ = 0.375 m

$l_{db} >= l_d$ hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (M_x)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 111.551 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 46.000 mm

Selected spacing (S) = 74.625 mm

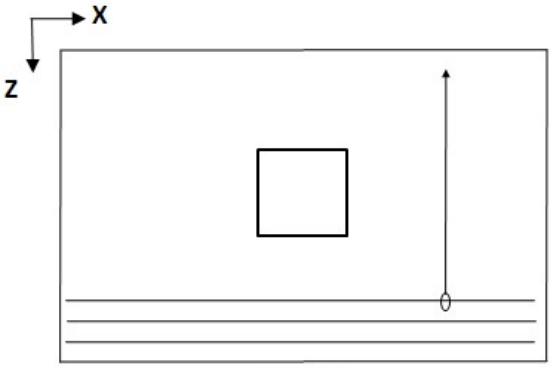
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Along X Axis



PLAN

For moment w.r.t. Z Axis (M_z)

As Per IS 456 2000 Clause 26.5.2.1

Critical Load Case = #1

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 139.891 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.625 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

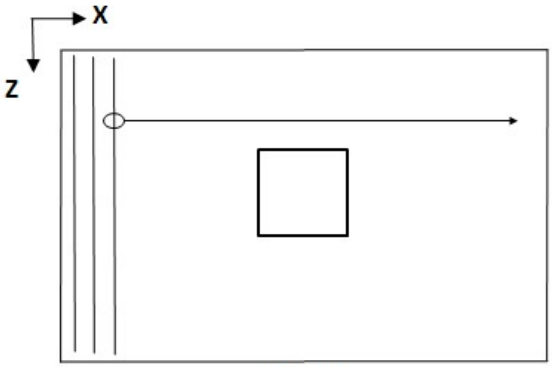
The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70.000 mm o.c.

Top Reinforcement Design

Along Z Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 475.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin} <= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 0.995 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = 50.000 mm

Selected spacing (S) = 74.625 mm

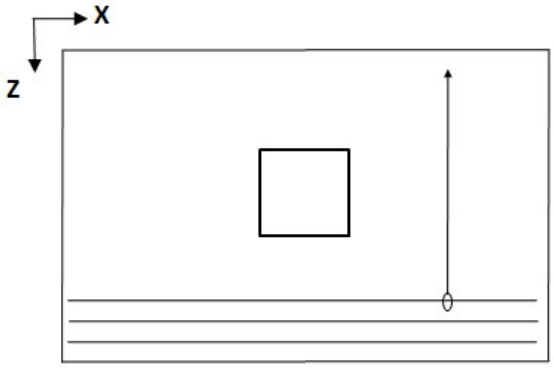
S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Along X Axis



PLAN

Minimum Area of Steel (A_{stmin}) = 475.800 mm2

Calculated Area of Steel (A_{st}) = 475.800 mm2

Provided Area of Steel ($A_{st,Provided}$) = 475.800 mm2

A_{stmin}<= $A_{st,Provided}$ Steel area is accepted

Governing Moment = 1.242 kNm

Selected bar Size (d_b) = Ø6

Minimum spacing allowed (S_{min}) = = 50.000 mm

Selected spacing (S) = 74.625 mm

S_{min} <= S <= S_{max} and selected bar size < selected maximum bar size...

The reinforcement is accepted.

Based on spacing reinforcement increment; provided reinforcement is

Ø6 @ 70 mm o.c.

Print Calculation Sheet