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STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Design Of Slabs : Default Level

Design Method : Limit State Method
Design Code : IS 456:2000

Design Of Slab

Slab Name : S1
Slab Type : TwoWay Slab
Grade of Concrete :M20
Grade of Steel : Fe415
Dimensions : Lx = 3.960 m ,Ly = 3.340 m ,Thickness= 105 mm
Span Ratio : Longer/Shorter = 1.186
Boundary Condition : One short and one long edge continuous

Loading on Slab :(Table 1)

Total DL = (1) + (2) + (3)

Self Weight (1) kN/m^2	Floor Finish (2) kN/m^2	Sunk Load (3) kN/m^2	Total DL (4) kN/m^2	Live Load (5) kN/m^2	Total LL (6) kN/m^2	Total Design Load 1.5 x [(4)+(6)] kN/m^2
2.625	1.000	0.000	3.625	2.000	2.000	8.438

Deflection Check :(Table 2)

As per clause 23.2.1 of IS 456:2000:

(Span/Depth) Ratio	Modification Factor	Basic Factor	Permissible Ratio	Status

	(a)	(b)	(a x b)	
31.810	1.000	32.000	32.000	OK

Moment And Steel Calculations :

Coefficients ($_x$ and $_y$) are computed as per clause D-1.1 of IS 456:2000:

$M_x = \ _x \times W \times L_x \times L_x$:

$M_y = \ _y \times W \times L_x \times L_x$:

where

M_x,M_y = moments on strips of unit width spanning L_x and L_y respectively,

W = Total Design Load = 8.438 kN/m²

L_x = Shorter span = 3.340 m

Position	Moment Coeff. $_x$ or $_y$	Moment kN-m	A_{st_rqd} per metre mm²	Steel Detail dia @ spc mm c/c	A_{st_prv} per metre mm²	Remark
MidShort	0.044	4.168	150.149	#8 @ 200	251.327	Main
MidLong	0.035	3.294	117.646	#8 @ 200	251.327	Other
SuppDown	0.000	0.000	0.000	--	0.000	Extra at Top
SuppTop	0.059	5.553	202.927	--	0.000	Extra at Top
SuppLeft	0.000	0.000	0.000	--	0.000	Extra at Top
SuppRight	0.047	4.424	159.783	--	0.000	Extra at Top

Minimum Steel Check :

As per clause 26.5.2.1 of IS 456:2000:

Minimum area of steel For Main Steel = 0.12 x C/S Area

= 126.000 mm²

Notes :

Extra steel at Top support is computed considering
the bent-ups,if any,coming from the adjoining span.
It is the maximum of the extra steel required
for each slab at that common support.

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Design Data Report :

Footing Data:

Soil Parameters :

SBC of soil = Bored pile foundation 15.M depth

SBC Increment Factor for Seismic Load = 1.500
SBC Increment Factor for Wind Load = 1.500
Angle of friction,(phi) = 30.00 degrees
Cohesion = 60.00
Permissible factor of safty = 1.400
Depth From Ground = 2000 mm

Material Properties :

fck = 25.00 N/mm²

fy = 500.00 N/mm²

Footing Parameters :

Minimum steel Percentage = 0.12
Minimum spacing between bars = 100 mm
Maximum spacing between bars = 200 mm
Diameters of selected bars = 10 mm , 12 mm .

Bottom Cover	= 50 mm
End Cover	= 50 mm
Minimum Footing Depth	= 150 mm
Top Offset	= 50 mm
Bottom PCCOffset	= 150 mm
Bottom PCCDepth	= 150 mm
Pedestal Offset	= 150 mm
Pedestal Depth	= 150 mm
Size RoundingFactor	= 25 mm
Depth RoundingFactor	= 25 mm
Number of Steps	= 1
Minimum Step Depth	= 150 mm

Column Data:

Material Properties :

fck	= 25.00 N/mm²
fy	= 500.00 N/mm²
fy - Stirrups	= 500.00 N/mm²

Column Parameters :

Effective Length Factor (X - Axis)	= 1.00
Effective Length Factor (Y - Axis)	= 1.00
Minimum Eccentricity @ X-Axis	= 20 mm
Minimum Eccentricity @ Y-Axis	= 20 mm
Clear Cover	= 40 mm

Design Considerations :

Design is done as per IS 456.

Detailing is done as per IS 13920.

Confinement reinforcement is provided.

Live Load reduction is considered.

Minimum steel percentage is based on provided section.

Reinforcement Details :

Steel Ratio(AstX/AstY)	= 1.00
ReinForcement Placing (on two sides or on four sides)	= 2

Minimum steel Percentage	= 0.80
Maximum steel Percentage	= 4.00
Minimum spacing between main bars	= 25 mm
Maximum spacing between main bars	= 300 mm
Minimum spacing between Stirrups	= 100 mm
Diameters of selected bars	= 12 mm , 16 mm , 20 mm , 25 mm , 32 mm .

Slab Data: Use Bent-up bars for steel detailing.

Material Properties :

RCC Grade	= M25
Main Steel Grade	= Fe500
Distribution Steel Grade	= Fe500

Slab Parameters :

Effective Cover	= 25 mm
Minimum spacing between Main bars	= 75 mm
Maximum spacing between Main bars	= 200 mm
Minimum spacing between Dist.bars	= 75 mm
Maximum spacing between Dist.bars	= 300 mm
Maximum Main/Dist. bar Diameter	= 32 mm
Minimum Main bar Diameter	= 8 mm
Minimum Dist.bar Diameter	= 8 mm
Maximum Dimension to be used for Trapizoidal Slab	= Average of two parellel sides
Maximum Dimension to be used for General Slab	= Maximum of two parellel sides

Beam Data:

Shear Design Data :

Minimun Stirrup Dia	= 8 mm
Stirrup Legs	= 2
Minimum Stirrups Spacing	= 100 mm
Stirrups Steel Grade Name	= Fe500

Effect of Concrete in shear considered

Beam Covers :

Tension Cover = 33 mm

Compression Cover = 33 mm

Side Cover = 25 mm

Beam sections are designed as Doubly Reinforced Section

Main Bars Detailing Straight + Curtailed

Detailing provision As per IS 13920 is followed

End Moments are calcultaed at c/c distance of the beam span for design

Torsion Moments are considered in beam design

Anchor bar Dia	= 8 mm
Main Steel Grade	= Fe500
No. of division of the beam	= 10
Max. Aggregate size	= 20

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Size of col./ped, (l x b) = 0.230 x 0.450 m

f_{ck} = 20000.00 kN/m²
f_y = 500000.00 kN/m²
$_{cc}$ = 5000.00 kN/m²
$_{cbc}$ = 7000.00 kN/m²
$_{sc}$ = 230000.00 kN/m²

Soil Parameters :

Pile Parameters :

Minimum diameter	= 0.45 m
Maximum diameter	= 0.45 m
Minimum Length	= 15.00 m
Maximum Length	= 15.00 m
Spacing	= 1.13 m

Max. No of Pile(s) per group = 25

Load combination = 1.50DL + 1.50EQL Y+

Loads On Footing :

Factored Load

Axial load ,(Pu)	= 746.15 kN (From analysis results)
BMu @ x-x,(M_x)	= 77.47 kN-m
BMu @ y-y,(M_y)	= 4.09 kN-m
Horizontal Force,HFu_x	= 2.79 kN
Horizontal Force,HFu_y	= 41.32 kN
Working Load	
Axial load ,(P)	= 497.43 kN (From analysis results)
BM @ x-x,(M_x)	= 51.65 kN-m
BM @ y-y,(M_y)	= 2.72 kN-m
Horizontal Force,HF_x	= 1.86 kN
Horizontal Force,HF_y	= 27.55 kN
Self Weight of pile cap assumed	= 10.00 % of P = 49.74 kN
Total load,(P)	= 547.18 kN
Uplift	= 0.00 kN
Moment due to Shear Force in X-direction	= SF_x x Pile Cap Depth (from Reynolds minimum depth equation, Ref. Reynolds Handbook)
	= 1.86 x 1.000
	= 1.86 kN-m
Moment due to Shear Force in Y-direction	= SF_y x Pile Cap Depth
	= 27.55 x 1.000
	= 27.55 kN-m
Total BM @ x-x,(M_x)	= 53.50 kN-m
Total BM @ y-y,(M_y)	= 30.27 kN-m

Provide 3 - 0.450 m dia. piles of length 15.000 m.
Provide 12 dia. 6 nos. in each pile.

Calculation Of Axial Load On A Pile :

Axial load on a pile = Direct axial load + additional loads due to moments + self weight of pile

Direct axial load,(F) = P/(no.of piles)
= 547.18 / 3 = 182.39 kN

For X-axis :

Additional load due to moments, (FaX) = km x M_x

Calculation of factor km :
Reference point = center of first pile row,
a = distance of a pile row from reference point,
x = distance of a pile row from CG of pile group,
n = no. of piles in a pile row from reference point.

Pile row	a (m)	n	a.n (m)	x (m)	$n.x^2$
1	0.000	2	0.000	-0.450	0.405
2	1.350	1	1.350	0.900	0.810
		3	1.350		1.215

Distance of CG from reference point,(xBar) = (a.n)/(no.of piles)=1.350/3=0.450 m

I = $(n.x^2)$ = 1.215

Maximum distance from CG of any pile row,(xMax) = 0.900 m

km = xMax / I = 0.900 /1.215 = 0.741

Additional load due to moments, (FaX) = km x M_x = 0.741 x 53.50 = 39.63 kN

For Y-axis :

Additional load due to moments, (FaY) = km x M_y

Calculation of factor km :
Reference point = center of first pile row,
a = distance of a pile row from reference point,
x = distance of a pile row from CG of pile group,
n = no. of piles in a pile row from reference point.

Pile row	a (m)	n	a.n (m)	x (m)	$n.x^2$
1	0.000	1	0.000	-1.350	1.822
2	1.350	1	1.350	0.000	0.000
3	2.700	1	2.700	1.350	1.822
		3	4.050		3.645

Distance of CG from reference point,(xBar) = (a.n)/(no.of piles)=4.050/3=1.350 m

I = $(n.x^2)$ = 3.645

Maximum distance from CG of any pile row,(xMax) = 1.350 m

km	= xMax / I = 1.350 /3.645 = 0.370
Additional load due to moments,	(FaY) = km x M_y = 0.370 x 30.27 = 11.21 kN

Self weight of pile,(Fsw) = /4 x (PileDia)^2 x pile length x density
(Fsw) = /4 x 0.450^2 x 15.000 x 25.000
Self weight of pile,(Fsw) = 59.64 kN

Axial load on a pile,(Fa) = F + FaX + FaY + Fsw = 182.39 + 39.63 + 11.21+ 59.64 = 292.88 kN

Calculation of a Pile Capacity

User Defined Pile Capacity = 550.00 kN

Factor of Safety = 1.50
Safe Pile Capacity(Q_u) = 550.00 / 1.50 = 366.67 kN > 292.88 kN. Hence SAFE

Calculation Of Pile Spacing

Min Pile Spacing as per IS:2911 = 1.350 m
Pile Spacing Provided = 1.350 m

Design Of Pile Cap :

Calculation Of Pile Cap Size :
Pile cap overhang = 0.150 m
Length = 0.150 + 1.800 + 0.150 = 2.100 m
Width = 0.150 + 3.150 + 0.150 = 3.450 m
Provide pile cap of size 2.100 x 3.450 x 0.750 m

Bending Moment Calculations :
As per IS 456: 2000 /Clause 33.2.3.2,critical section for checking bending moment
in the design of an isolated concrete footing which supports a column shall be
a section located at the face of the column or pedestal.

As per IS 2911: (Part III)1980 /Clause 5.4.2,the reaction of any pile whose centre is
located D/2 or more outside the section shall be assumed as producing shear on the section;

the reaction of any pile whose centre is located D/2 or more inside the section shall be assumed as producing no shear on the section.

Column face considered : Left face

For X-axis :

x-dist and y-dist are the distances of pile centres from column centres.

Pile no.	x-dist (m)	y-dist (m)	Distance from column face,a (m)	Location w.r.t. critical section	Pile reaction,R (kN)	BM (kN-m)
2	0.900	0.000	0.785	Outside (a >= 0.225)	343.34	0.785 x 343.34 = 269.52
					Total	269.52

For Y-axis :

x-dist and y-dist are the distances of pile centres from column centres.

Pile no.	x-dist (m)	y-dist (m)	Distance from column face,a (m)	Location w.r.t. critical section	Pile reaction,R (kN)	BM (kN-m)
3	-0.450	1.350	1.125	Outside (a >= 0.225)	343.34	1.125 x 343.34 = 386.26
					Total	386.26

Column face considered : Right face

For X-axis :

x-dist and y-dist are the distances of pile centres from column centres.

Pile no.	x-dist (m)	y-dist (m)	Distance from column face,a (m)	Location w.r.t. critical section	Pile reaction,R (kN)	BM (kN-m)
1	0.450	1.350	0.335	Outside (a >= 0.225)	343.34	0.335 x 343.34 = 115.02
3	0.450	-1.350	0.335	Outside (a >= 0.225)	343.34	0.335 x 343.34 = 115.02
					Total	230.04

For Y-axis :

x-dist and y-dist are the distances of pile centres from column centres.

Pile no.	x-dist (m)	y-dist (m)	Distance from column face,a (m)	Location w.r.t. critical section	Pile reaction,R (kN)	BM (kN-m)
1	0.450	1.350	1.125	Outside (a >= 0.225)	343.34	1.125 x 343.34 = 386.26

Total	386.26

Depth Calculations :

Depth required for punching shear:

As per IS : 456 - 2000 - Clause 31.6.3.1,the calculated shear stress at the critical section shall not exceed ks x TauC

where,

ks = 0.5 + $_c$, but not greater than 1, $_c$ being the ratio of short side to the long side of column, and

TauC = 0.25 x (fck)in Limit state method of design.

Depth required for punching shear is calculated by equating the actual stress to permissible stress and by solving the resulting equation.

Minimum depth calculation :

(Ref.Reynolds Handbook.)

Minimum depth	= (2.00 x pile size.) + 0.100 = (2.00 x 0.450) + 0.100
	= 1.000 m
User defined minimum pile cap Depth,	= 0.600 m
Depth assumed,(D)	= 0.625 m
Bottom cover	= 0.075 m
Effective depth,(d_{effX})	= 0.544 m
Effective depth,(d_{effY})	= 0.532 m
Effective depth,(d_{eff})	= 0.544 m
Resisting area,(A_r)	= d_{eff} x 2 x (b + d_{eff}/2 + 1 + d_{eff})/2 = 0.544 x 2 x (0.230 + 0.450)
	= 1.332 m^2
Shear force,(V)	= 746.15 kN
Actual shear stress	= V / A_r = 746.15 / 1.332 = 560.29 kN/m^2
Maximum permissible shear stress	= 0.25 x (fck) x ks
ks	= 0.5 + $_c$
$_c$	= short column side/ long column side
	= 0.230 / 0.450 = 0.511
ks	= 0.5 + 0.511 = 1.011 > 1 , ks = 1
Maximum permissible shear stress	= 0.25 x 4.4721 x 1.000

$= 1.118\ N/mm^2 = 1118.03\ kN/m^2$

Actual shear stress < Maximum permissible shear stress.

Hence,Safe in punching shear.

Calculation Of Moment Of Resistence :

Column face considered : Left face

Total depth,(D) = 0.625 m For (Fe500),k = 0.456

R = 0.36 x fck x k x (1 - 0.42 x k)
= 0.36 x 20000.000 x 0.456 x (1 - 0.42 x 0.456)
= 2654.804

Moment of resistanceX = R x width x d_{effX} x d_{effX}
= 2654.804 x 2.630 x 0.544 x 0.544
= 2066.26 kN-m> 269.52 kN-m

Moment of resistanceY = R x width x d_{effY} x d_{effY}
= 2654.804 x 2.100 x 0.532 x 0.532
= 1577.88 kN-m> 386.26 kN-m

Column face considered : Right face

Moment of resistanceX = R x width x d_{effX} x d_{effX}
= 2654.804 x 2.170 x 0.544 x 0.544
= 1704.86 kN-m> 230.04 kN-m

Moment of resistanceY = R x width x d_{effY} x d_{effY}
= 2654.804 x 2.100 x 0.532 x 0.532
= 1577.88 kN-m> 386.26 kN-m

Steel Calculations :

Column face considered : Left face

For M_{ux} :

Cross sectional area,(csArea) = width at NA x d_{effX} = 2.630 x 0.544 = 1.431 m^2

val = 1 - [(4.6 x MuX)/(fck x B x $deffX^2$)]

Required steel area,(AstX) = [0.5(fck/fy) x (1 - sqrt(val))] x csArea
= 1163 mm²

Required steel pt. = 0.08130 % < minimum steel pt.(min-pt = 0.120 %)

Required steel area,(AstX) = min-pt x csArea/100 = 0.120 x 1.431/100
= 1717 mm²

For M_{uy} :

Cross sectional area,(csArea) = width at NA x d_{effY} = 2.100 x 0.532 = 1.117 m²

val = 1 - [(4.6 x MuY)/(fck x B x deffY²)]

Required steel area,(AstY) = [0.5 (fck/fy) x (1 - sqrt(val))] x csArea
= 1737 mm²

Required steel pt. = 0.15552 %

Column face considered : Right face

For M_{ux} :

Cross sectional area,(csArea) = width at NA x d_{effX} = 2.170 x 0.544 = 1.180 m²

val = 1 - [(4.6 x MuX)/(fck x B x deffX²)]

Required steel area,(AstX) = [0.5(fck/fy) x (1 - sqrt(val))] x csArea
= 993 mm²

Required steel pt. = 0.08416 % < minimum steel pt.(min-pt = 0.120 %)

Required steel area,(AstX) = min-pt x csArea/100 = 0.120 x 1.180/100
= 1417 mm²

Provide 12 Tor 34 nos.(3845 mm²)
(considering flexural and shear check requirements)

Spacing = (B - dia. - (2 x end cover))/(no - 1) = (3.450 - 0.012 - (2 x 0.050))/(34 - 1)
= 0.101 m < maximum spacing(0.200 m)

For M_{uy} :

Cross sectional area,(csArea) = width at NA x d_{effY} = 2.100 x 0.532 = 1.117 m²

val = 1 - [(4.6 x MuY)/(fck x B x deffY²)]

Required steel area,(AstY) = [0.5 (fck/fy) x (1 - sqrt(val))] x csArea
= 1737 mm²

Required steel pt. = 0.15552 %

Provide 12 Tor 19 nos.(2149 mm²)

					(a >= 0.225)	
					Total	343.34

Shear force,(Vy) = 343.34 kN

Resisting area,(A_r) = d_{effY} x L = 0.532 x 1.937 = 1.031 m²
Actual shear stress = Vy / A_r = 343.34 / 1.031
= 333.10 kN/m²

Column face considered : Right face

For X-axis :
Projection-X,(proj) = (L - l)/2 - (d_{effX}/2) = (2.100 - 0.230)/2 - (0.544/2) = 0.663 m

x-dist and y-dist are the distances of pile centres from column centres.

Distance of critical section from the face of column = 0.313 m

Pile no.	x-dist (m)	y-dist (m)	Distance from column face (m)	Distance from critical section,a (m)	Location w.r.t. critical section	SF (kN)
1	-0.450	-1.350	0.335	0.022	Outside (a < 0.225)	188.84
3	-0.450	1.350	0.335	0.022	Outside (a < 0.225)	188.84
					Total	377.68

Shear force,(Vx) = 377.68 kN

Resisting area,(A_r) = d_{effX} x B = 0.544 x 1.545 = 0.840 m²
Actual shear stress = Vx / A_r = 377.68 / 0.840
= 449.36 kN/m² < permissible shear stress(461.41 kN/m²)

For Y-axis :
Projection-Y,(proj) = (B - b)/2 - (d_{effY}/2) = (3.450 - 0.450)/2 - (0.532/2) = 1.234 m

x-dist and y-dist are the distances of pile centres from column centres.

Distance of critical section from the face of column = 0.313 m

Pile no.	x-dist (m)	y-dist (m)	Distance from column face (m)	Distance from critical section,a (m)	Location w.r.t. critical section	SF (kN)

(considering flexural and shear check requirements)

Spacing = (L - dia. - (2 x end cover))/(no - 1) = (2.100 - 0.012 - (2 x 0.050))/(19 - 1)
= 0.110 m < maximum spacing(0.200 m)

Check For One Way Shear :

As per IS:2911(Part III)-1980 /Clause 5.4.2,the critical section for this condition shall be assumed as a vertical section located at a distance equal to the half the
depth of pile cap from the face of the column or pedestal.

Column face considered : Left face

For X-axis :

Projection-X,(proj) = (L - l)/2 - (d_{effX}/2) = (2.100 - 0.230)/2 - (0.544/2) = 0.663 m

x-dist and y-dist are the distances of pile centres from column centres.

Distance of critical section from the face of column = 0.313 m

Pile no.	x-dist (m)	y-dist (m)	Distance from column face (m)	Distance from critical section,a (m)	Location w.r.t. critical section	SF (kN)
2	0.900	0.000	0.785	0.472	Outside (a >= 0.225)	343.34
					Total	343.34

Shear force,(Vx) = 343.34 kN

Resisting area,(A_r) = d_{effX} x B = 0.544 x 3.255 = 1.771 m²

Actual shear stress = Vx / A_r = 343.34 / 1.771
= 193.90 kN/m² < permissible shear stress(461.41 kN/m²)

For Y-axis :

Projection-Y,(proj) = (B - b)/2 - (d_{effY}/2) = (3.450 - 0.450)/2 - (0.532/2) = 1.234 m

x-dist and y-dist are the distances of pile centres from column centres.

Distance of critical section from the face of column = 0.313 m

Pile no.	x-dist (m)	y-dist (m)	Distance from column face (m)	Distance from critical section,a (m)	Location w.r.t. critical section	SF (kN)
3	-0.450	1.350	1.125	0.812	Outside	343.34

1	-0.450	-1.350	1.125	0.812	Outside (a >= 0.225)	343.34
					Total	343.34

Shear force,(Vy) = 343.34 kN

Resisting area,(A_r) = d_{effY} x L = 0.532 x 1.937 = 1.031 m²

Actual shear stress = Vy / A_r = 343.34 / 1.031

= 333.10 kN/m²

Summary :

Provide 2 - 0.450 m dia. piles of length 15.000 m.

Provide 16 dia. 8 nos. in each pile.

Provide pile cap of size (L x B1 x B2 x D) :

2.100 x 3.450 x 0.9 x 0.68 m

Provide 12 dia. 34 nos along L

Provide 12 dia. 19 nos along B1.

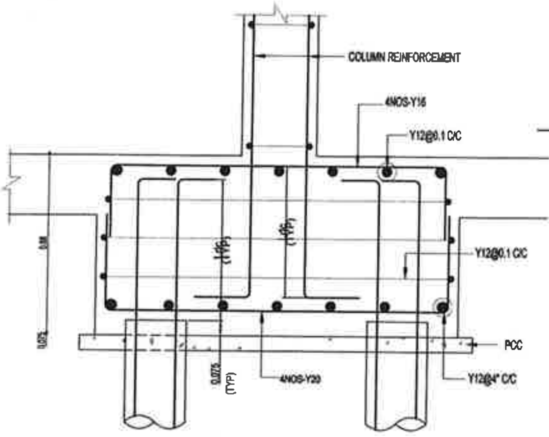
Pile Capacity Table

S.No.	Length (m)	Dia (m)	Capacity (kg)
1	15.000	0.450	55000

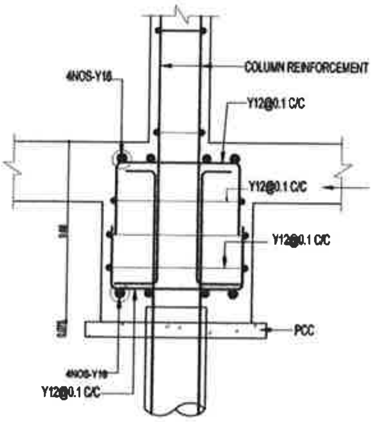
COLUMN SCHEDULE

SNO	COLUMN REFERENCE	SIZE	COLUMN SHAPE	MAINSTEEL	BINDERS	BINDERS	TIE DETAILS
01.	C1	0.45X0.23	0.45 / 0.23	8Y20	-REFER - -SECTION-	M_{25}	
02.	C2	0.45X0.23	0.45 / 0.23	8Y25	-REFER - -SECTION-	M_{25}	
03.	C3	0.45X0.30	4Y12 / 0.45 / 0.075 / 0.23	8Y20	-REFER - -SECTION-	M_{25}	
04.	C4	0.45X0.30	4Y12 / 0.45 / 0.075 / 0.23	8Y25	-REFER - -SECTION-	M_{25}	
05.	C5	0.60X0.30	0.60 / 0.075 / 0.23 / LINK BAR	10Y25	-REFER - -SECTION-	M_{25}	

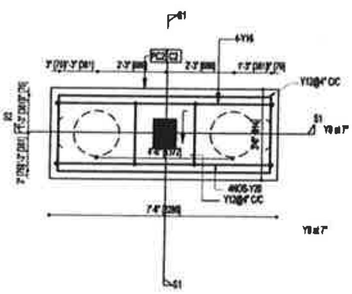
▨ --portion can be removed above still floor roof &reinforcement

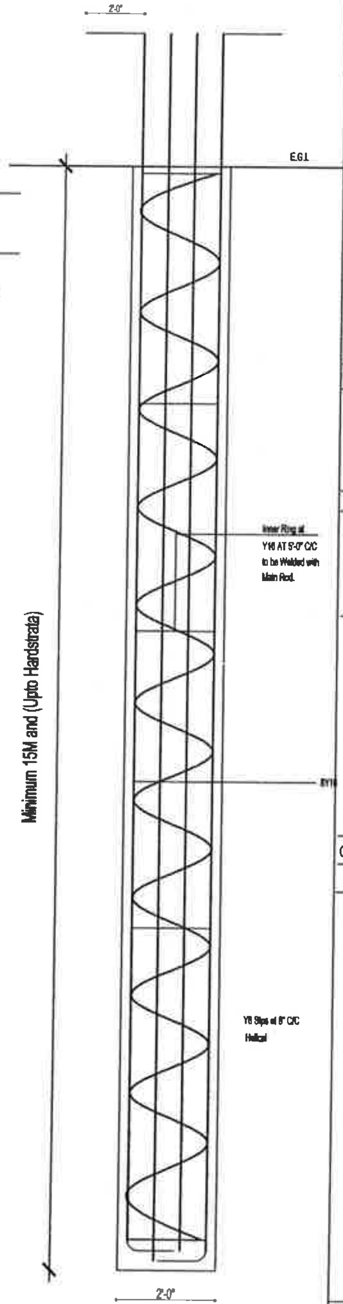


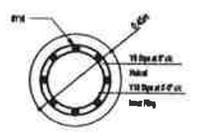
SECTION S2-S2



SECTION 'S1-S1'







C.S OF PILE

PROJECT:

PLAN SHOWING THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.0 M (HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO. 19/2,PLOT NO. 20&21 CANAL ROAD,KAMARAJ NAGAR, THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO37/1A1A T.S.NO.89/2,BLOCK NO.11,WARD-1OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITH IN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE:13 DIVISION:180

NOTES:

1. ALL DIMENSIONS ARE IN FEET&INCHES UNLESS OTHER WISE SPECIFIED
2. M20 GRADE OF CONCRETE AND FE 500 GRADE SHALL BE USED

03.CLEAR COVER TO MAIN STEEL SHALL BE
1" FOR BEAMS
1.5" FOR COLUMNS.
2"FOR FOOTINGS,
5/8"FOR SLABS&SUNSHADES

4.FOUNDATION IS DESIGNED FOR STILT+5 FLOOR ONLY.
5.SBC CONSIDERED AT 15 M BELOW EXG. GL IS BORED PILE FOUNDATION AS PER SOIL REPORT.
6.BUILDING IS DESIGNED FOR 1.5L.L+1.5 D.L ONLY+SEISMIC ONLY..
7.Y DENOTES TOR 40 STEEL CONFIRMING TO IS 1786-1985.
8. 'R' DENOTES MILD STEEL CONFIRMING TO I.S.432-1982.
9.FORM WORK TO BE REMOVED FOR SPANS
UPTO 0M—3M 7DAYS
3M—4.5M 14DAYS
4.5M—6M 21DAYS
10.AVOID CLAY SOIL FILLING IN BASEMENT.
11.USE 1;1;2 MIX FOR STARTERS
12.USE OPC FOR ALL CONCRTE WORKS.
13.LAP LENGTH SHALL BE 47 TIMES THE DIA OF BAR.
14.ALL COLUMN RODS TO BE STAGGERED
15.NO DIMENSION SHOULD BE SCALED OFF FROM THE DRG. ONLY WRITTEN DIMENSION SHOULD BE FOLLOWED.
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18.ALL FOOTING RODS BENT 4"UP.
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■ ONUS OF CONSTRUCTION LIES WITH CONTRACTOR/OWNER

R.NO.	REVISION	DATE	SIGN
1.	OLD COLUMN POSITIONS C2&F2 MOVED FOR CAR PARKING	7.7.2023	
2.			
3.			

PROJECT NO:

DRG TITLE:

FOUNDATION LAYOUT

STRUCTURAL DRAWING

DRG.NO : SD-01 ONLY.

SCALE : 1"=4'-0" & 1"=2'-0"

DATE : 17.10.2023

SHEET SIZE : A_1 (1/1)

CAD FILE: E:\SHANKAR/2023/AVITTAM HOMES/ THIRUVANMIYUR/FDN

GOOD FOR CONSTRUCTION

GENERAL NOTES ON PILES.

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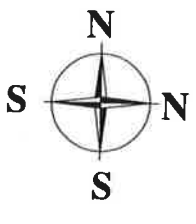

STRUCTURAL CONSULTANTS:

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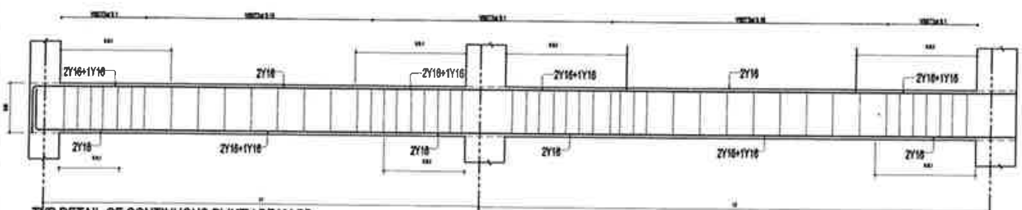
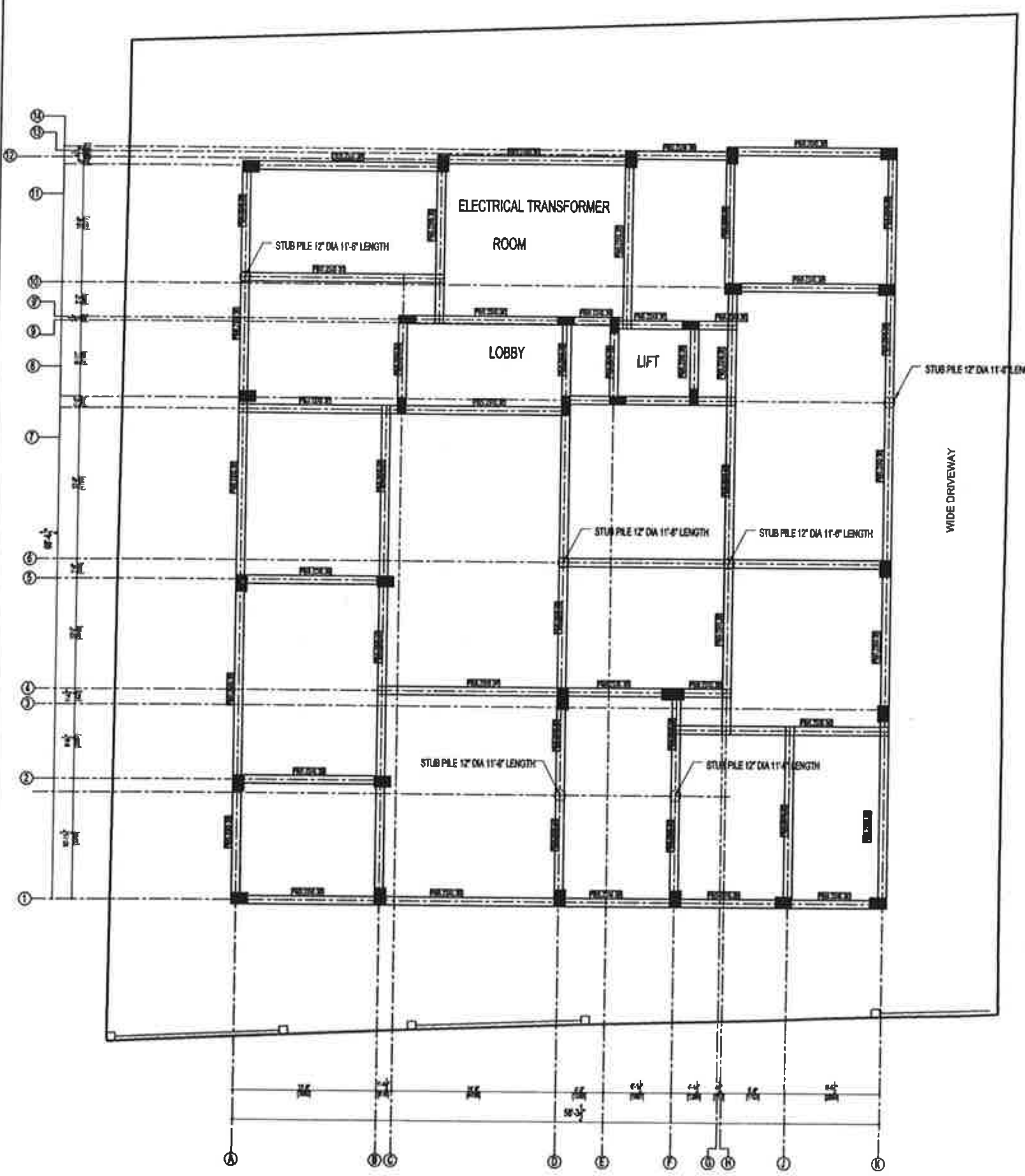
PH:65419436
MOBILE:9282102586.
e-mail m_shankarengineer@yahoo.co.in



TYP.DETAIL OF CONTINUOUS PLINTH BEAM PB



PLINTH BEAM LAYOUT

PROJECT:
PLAN SHOWING THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(16.0 M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO. 19/2,PLOT NO. 20&21 CANAL ROAD,KAMARAJ NAGAR, THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO37/1A1A T.S.NO.89/2,BLOCK NO.11,WARD-1OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITH IN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE:13 DIVISION:180

NOTES:

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ONUS OF CONSTRUCTION LIES WITH CONTRACTOR/OWNER

R.NO.	REVISION	DATE	SIGN
1.			
2.			
3.			

PROJECT NO:

DRG TITLE: PLINTH BEAM LAYOUT

STRUCTURAL DRAWING

DRG.NO : SD-01 ONLY.

SCALE : 1"=4'-0" & 1"=2'-0"

DATE : 17.10.2023

SHEET SIZE : A1 | 1/1

CAD FILE: E/SHANKAR/2023/AVITTAM HOMES/ THIRUVANMIYUR/FDN

GOOD FOR CONSTRUCTION

GENERAL NOTES ON PILES.

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3.COVER BLOCK OF HOLLOW CIRCULAR SHAPE IN 1:1CM SHALL BE USED
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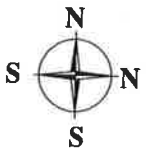

STRUCTURAL CONSULTANTS:
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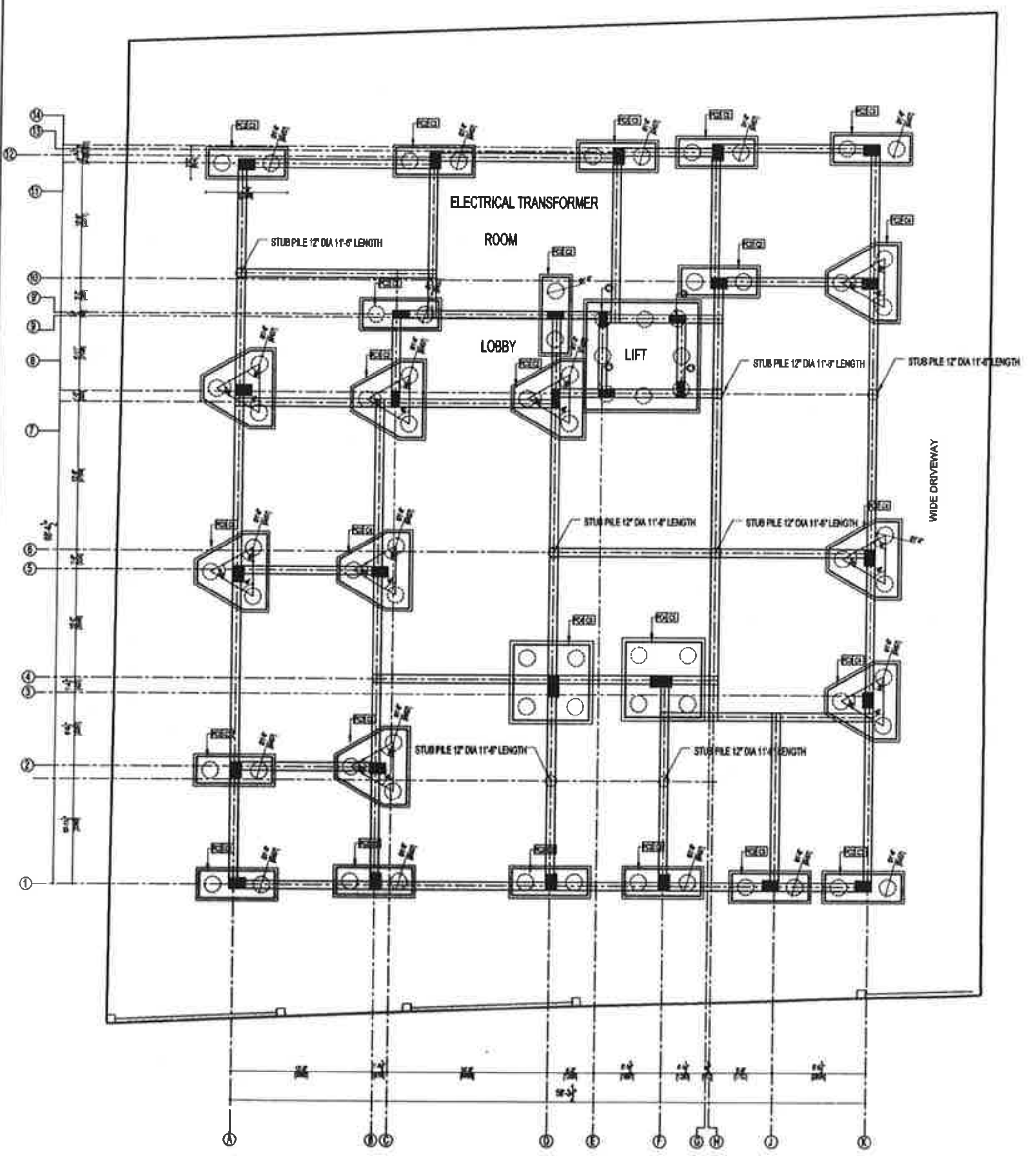

PILE FOUNDATION LAYOUT

PROJECT:
PLAN SHOWING THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.0 M (HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO. 19/2,PLOT NO. 20&21 CANAL ROAD,KAMARAJ NAGAR, THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO37/1A1A, T.S.NO.89/2,BLOCK NO.11,WARD-1OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITH IN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE:13 DIVISION:180

NOTES:

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   5/8" FOR SLABS&SUNSHADES
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   UPTO 0M—3M 7DAYS
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R.NO.	REVISION	DATE	SIGN
1.		7.7.2023	
2.			
3.			

PROJECT NO:

DRG TITLE:

FOUNDATION LAYOUT

STRUCTURAL DRAWING

DRG.NO	: SD-01 ONLY.
SCALE	: 1"=4'-0" & 1"=2'-0"
DATE	: 17.10.2023
SHEET SIZE :	A_1

1/1

CAD FILE: E:SHANKAR/2023/AVITTAM HOMES/ THIRUVANMIYUR/FDN

GOOD FOR CONSTRUCTION

GENERAL NOTES ON PILES.

1. MINIMUM CEMENT CONTENT FOR PILES SHALL BE 400KG/M3 WITH M30 GRADE
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PH:65419436
MOBILE:9282102566.
e-mail m_shankarengineer@yahoo.co.in

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Beam Detail Report

F FLOOR - Default Level

Load Combinations used in beam design :

Load Combi No	Load Combination	Load Combi No	Load Combination
1	1.50 DL + 1.50 LL	2	1.20 DL + 1.20 LL + 1.20 EQL X+
3	1.20 DL + 1.20 LL + 1.20 EQL X-	4	1.20 DL + 1.20 LL + 1.20 EQL Y+
5	1.20 DL + 1.20 LL + 1.20 EQL Y-	6	1.50 DL + 1.50 EQL X+
7	1.50 DL + 1.50 EQL X-	8	1.50 DL + 1.50 EQL Y+
9	1.50 DL + 1.50 EQL Y-	10	1.20 DL + 1.20 LL + 1.20 WL X+
11	1.20 DL + 1.20 LL + 1.20 WL X-	12	1.20 DL + 1.20 LL + 1.20 WL Y+
13	1.20 DL + 1.20 LL + 1.20 WL Y-	14	1.50 DL + 1.50 WL X+
15	1.50 DL + 1.50 WL X-	16	1.50 DL + 1.50 WL Y+
17	1.50 DL + 1.50 WL Y-	18	0.90 DL + 1.50 EQL X+
19	0.90 DL + 1.50 EQL X-	20	0.90 DL + 1.50 EQL Y+
21	0.90 DL + 1.50 EQL Y-	22	0.90 DL + 1.50 WL X+

23	0.90 DL + 1.50 WL X-	24	0.90 DL + 1.50 WL Y+
25	0.90 DL + 1.50 WL Y-		

Design of Beam Group : BG1

Beam : B1

Material Properties :

fck = 20.000 N/mm²

fy = 500.000 N/mm²

1.Design Data :

1.1)Dimensions:

Beam Type = 'Rectangular Beam'
Width (b) = 230 mm
Total depth (D) = 600 mm
Effective Tension Cover = 33mm
Effective Compression Cover = 33mm
Clear side Cover = 25mm
Effective depth (d) = 567mm
Span = 3.960m
Clear Span (L) = 3.960m

1.2)Loading on the Beam :

1.2.1)Self wt. of beam : -3.450 kN/m

1.2.2)Slab Load

Dead Load :

Trapezoidal Load in kN/m

St.Pt 1.670 m L = 3.960 m Max. Value = -5.845 kN/m

LiveLoad

Trapezoidal Load in kN/m

St.Pt 1.670 m L = 3.960 m Max. Value = -3.340 kN/m

1.2.3)Wall Load

UDL in kN/m

St.Pt 0.000 m L = 3.960 m Max. Value = -10.488 kN/m

2.Computation of Area of steel :

2.1) Flexural Steel at Top and Bottom

2.1.1)Computation of theoretical steel

At length	0.000 L	0.100 L	0.200 L	0.300 L	0.400 L	0.500 L	0.600 L	0.70 0L	0.80 0L	0.900 L	1.000 L

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Annexure – XIV

[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1 | **General Data**

Annexure – XIV

[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1	**General Data**		
S.No.	**Description**	**Information**	**Notes**
1.	Site Address		
2	Name of Owner		
3	Name of Registered Developer along with the Registration Number		
4	Name of Registered Architect/Engineer along with the Registration Number		
5	Name of Registered Structural engineer along with the Registration Number	**SE/GR-II/19/3/021**	
6	Use of the building	**RESIDENTIAL**	
7	Number of stories above ground level	**STILT+4FLO**	

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Annexure – XIV

[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1	General Data		
	(including storeys to be added later, if any)	**ORS+5 FLOOR (PART)**	
8	Number of basements below ground level	**NIL**	
9	Type of structure Load bearing walls R.C.C. frame R.C.C. frame and Shear Walls Steel frame	**RC FRAME**	
10	Soil data Type of soil Design safe bearing capacity	**BORED PILE FOUNDATIO N 15 M DEPTH AS PER SOIL REPORT**	IS:1893 C1.6.3.5.2 IS: 1904 IS: 1892 IS: 2131 IS: 2720
11	Dead loads (unit weight adopted) • Earth: **18KN/CUM** • Water: **10KN/CUM** • Brick masonry:**19.2KN/CUM** • Plain cement concrete **24KN/CUM** • Reinforced cement concrete:**25 KN/CUM** • Floor finish **50KG/SQM** • Other fill materials		IS: 875 Part 1

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Annexure – XIV

[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part 1	General Data		
12	Imposed (live) loads Floor loads Roof loads	**4KN/SQM** **1.5KN/SQM**	IS: 875 Part 2

13	Cyclone/Wind • Speed • Design pressure intensity	**N/A**	IS: 875 Part 3
14	Seismic zone	**III**	IS: 1893 (2002)
15	Importance factor	**1**	IS:1893(2002) Table 6
16	Seismic zone factor (Z)	**0.16**	IS:1893 Table 2
17	Response reduction factor		IS:1893 Table 7
18	Fundamental natural period – approx.	**0.29SEC**	IS:1893 C1.7.6
19	Design horizontal acceleration spectrum value (A_h)		IS: 1893 C1.6.4.2
20	♥ Expansion/Separation Joints	**N/A**	
21	Building is regular/irregular	**REGULAR**	IS 1893

♥ Enclose detailed drawings drawn to scale for each floor

♦ In case terrace garden is provided, indicate additional fill load and live load along with the detailed drawings drawn to scale

Part 2	**Load bearing masonry buildings**

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Annexure – XIV

[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

<table>
<tr><th>Part 1</th><th colspan="3">General Data</th></tr>
<tr><th>Sl.No.</th><th>Description</th><th>Information</th><th>Notes</th></tr>
<tr><td>1</td><td>Building category</td><td>N/A</td><td>IS: 4326 C1.7
Read with IS:1893<table><tr><td>Zone
Bldg.</td><td>II</td><td>III</td><td>IV</td><td>V</td></tr><tr><td>Ordinary</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Important</td><td>C</td><td>D</td><td>E</td><td>E</td></tr></table></td></tr>
<tr><td>2</td><td>Basement Provided</td><td>N/A</td><td></td></tr>
<tr><td>3</td><td>Number of floors including Ground Floor (all floors including stepped floors in hill slopes)</td><td>N/A</td><td></td></tr>
<tr><td>4</td><td>Type of wall masonry</td><td>N/A</td><td></td></tr>
<tr><td>5</td><td>Type and mix of Mortar</td><td>N/A</td><td>IS: 4326 C1.8.1.2</td></tr>
<tr><td>6</td><td>Re: size and position of openings (See note No.[i])
• Minimum distance (b5)
• Ratio $(b_1+b_2+b_3)/1_1$ or $(b_6+b_7)/1_2$
• Minimum pier width between consequent opening (b_4)
• Vertical distance (h_3)
• Ratio of wall height to thickness 4</td><td>N/A</td><td>IS: 4326 Table 4, Fig.7</td></tr>
</table>

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

Annexure – XIV

[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part 1	General Data		
	Ratio of wall length between cross wall to thickness		
7	Horizontal seismic band • at plinth level **N/A** • at window sill level **N/A** • at lintel level **N/A** • at ceiling level **N/A**	P IP NA	(see note No.2) IS:4326 C1 8.4.6 IS: 4326 C1 8.3 IS: 4326 C1 8.4.2 IS: 4326 C1 8.4.3 IS: 4326 C1 8.4.3
	• at eave level of sloping roof **N/A** • at top of gable walls **N/A** • at top of ridge walls **N/A**		IS: 4326 C1 8.4.3 IS: 4326 C1 8.4.4
8	Vertical reinforcing bar **N/A** at corners and T junction of walls at jambs of doors and window openings **N/A**		IS: 4326 C1 8.4.8. IS: 4326 C1 8.4.9
9	Integration of prefab roofing/flooring elements through reinforced concrete screed. **N/A**		IS:4326 C1 9.1.4
10	Horizontal bracings in pitched truss in horizontal plane at the level of		

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1	General Data		
	ties in the slopes of pitched roofs **N/A**		

Notes: (i) Information in Item 6 should be given on separate A4 sheets for all walls with large number of openings

(ii) IP indicated "Information Provided"

IP indicates "Information to be provided" NA indicates "Not Applicable"

Tick mark one box

Part 3	**Reinforced concrete framed buildings**		
Sl. No.	**Description**	**Information**	**Notes**
1	Type of building • Regular frames • Regular frames with Shear Walls • Irregular frames • Irregular frames with Shear Walls • Soft storey	**REGULAR FRAMES**	IS: 1893 C1 7.1
2	Number of basements	**NIL**	
3	Number of floors including ground floor	**S+4+5 TH FLOOR**	

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part 1	General Data		
		(PART)	
4	Horizontal floor system • Beams and slabs • Waffles • Ribbed floor • Flat slab with drops • Flat plate without drops	**BEAM AND SLAB**	
5	Soil data • Type of soil • Recommended type of foundation -Independent footings -Raft -Piles • Recommended bearing capacity of soil	**CLAYELY SOIL WITH BORED PILE FOUNDATIO N**	IS: 1498

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part 1	General Data		
	• Recommended type, length, diameter and load capacity of piles • Depth of water table • Chemical analysis of ground water • Chemical analysis of soil		
6	Foundations Depth below ground level Type Independent Interconnected Raft Piles	**BORED PILE FOUNDATIO N**	
7	System of interconnecting foundations Plinth beams Foundation beams	**PLINTH BEAM**	IS: 1893 C1 7.12.1
8	Grades if concrete used in different parts of building	**M25 FOR COLUMNS& M20 FOR REST**	
9	Method of analysis used	**FEM**	
10	Computer software used	**STRUDS V12**	
11	Torsion included	**INCLUDED**	IS: 1893 C1 7.9
12	Base shear	**BASED ON APPROXIMATE**	

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part 1	General Data		
	a. Based on approximate fundamental period b. Based on dynamic analysis c. Ratio of a/b	**FUNDAMENTAL PERIOD**	IS: 1893 Cl. 7.5.3
13	Distribution of seismic height forces along the of the building.	**REFER SESIMIC JUSTIFICATION**	IS:1893 Cl.7.7 (Provide sketch)
14	The Column of soft ground storey specially designed.	**YES**	IS: 1893 Cl.7.10
15	Clear minimum cover provided in • **Footing 50MM** • **Column 40MM** • **Beams 25MM** • **Slabs 20MM** • **Walls**		IS: 456 Cl. 26.4
16	Ductile detailing of RC frame • Type of reinforcement used **Fe 500D** • Minimum dimension of beams **230MM** • Minimum dimension of columns **230MM** • Minimum percentage of reinforcement of beams at any cross section **0.20%** • Maximum percentage of reinforcement at any section of beam **4%** • Spacing of transverse reinforcement in 2-d length of beams near the ends **100MM**		IS: 456 Cl. 5.6 IS: 13920 Cl.6.1 IS: 13920 Cl.7.1.2 IS: 456 Cl.26.5.1(a) IS: 13920 Cl.6.2.1 IS: 456 Cl.26.5.1.1(b) IS: 13920 Cl.6.2.2 IS: 13920 Cl.6.3.5

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1	General Data		
	• Ratio of capacity of beams in shear to capacity of beams in flexure **<1** • Maximum percentage of reinforcement in column **4%**		IS: 456 Cl.26.5.3.1 IS: 13920 Cl. 7.4
	• Confining stirrups near ends of columns and in beam-column joints Diameter **8mm** Spacing **100MM** • Ratio of shear capacity of columns to maximum seismic shear in the storey. **<1**		
17	Does the features require clearance by SDRP Example: High rise building Prefab building Building in hazard prone areas	**N/A**	

Foundation

i. In case raft foundation has been adopted, indicate K value used for analysis of the raft.

ii. Incase pile foundations have been used, give full particulars of the piles, type, dia, length, capacity

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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[See rule 51 (3)]

Form 1

Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1	General Data

iii. In case of high water table, indicate system of countering water pressure, and indicate the existing water table, and that assumed to design foundations.

Idealization for Earthquake analysis

i. In case of composite system of shear walls and rigid frames, give distribution of base shear in the two systems on the basis of analysis, and that used for design of each system

ii. Indicate the idealization of frames and shear walls adopted in the analysis with the help of sketches.

iii. Submit framing plans of each floor

iv. In case of basements, indicate the system used to contain earth pressures.

Part 4	Buildings in structural steel		
1	Adopted method of design	o Simple o Semi-rigid o Rigid	IS:800 Cl 3.4.4 IS:800 Cl.3.4.5 IS:800 Cl.3.5.6
2	Design based on	o Elastic analysis o Plastic analysis	IS: 800 Section-9 SP;6 (6)
3	Floor construction	o Composite o Non composite o Boarded	

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part 1	General Data		
4	Roof construction	○ Composite ○ Non composite ○ Metal ○ Any other	
5	Horizontal force resisting system adopted	Frames Braced frames Frames & shear walls	Note: Seismic force As per IS:1893 Would depend on system
6	Slenderness ratios maintained	Members defined in Table 3.1, IS:800	IS 800; Cl.3.7
7	Member deflection limited to	Beams, Rafters Crane Girders, Purlins Top of columns	IS:800 Cl.3.13
8	Structural members	○ Encased in concrete Not encased	IS: 800 Section-10
9	Proposed material	○ General weld-able ○ High strength ○ Cold formed ○ Tubular	IS: 2062 IS: 8500 IS: 801, 811 IS: 806
10.	Minimum metal thickness Specified for corrosion protection	○ Hot rolled sections ○ Cold formed sections ○ Tubes	IS: 800, Cl.3.8 Cl.3.8.1 to Cl.3.8.4 Cl.3.8.5
11	Structural connections	○ Rivets	IS: 800, Section-8

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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(1) This report to accompany the application for Building Developments

Part1	General Data		
		○ CT Bolts ○ S H F G Bolts ○ Black Bolts ○ Welding field Shop (Specify welding type proposed) Composite	IS: 1929, 2155, 1149 IS 6639, 1367 IS 3757, 4000 IS: 1363, 1367 IS: 816, 814,1395, 7280, 3613, 6419, 6560, 813, 9595
12	Minimum **Fire** rating proposed, with method	○ Rating… hours ○ Method proposed. -In tumescent painting -Spraying -Quilting -Fire retardant boarding	IS: 1641, 1642, 1643

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

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Structural Design Basis Report

(1) This report to accompany the application for Building Developments

Part1	**General Data**

STRUCTURAL ENGINEER

STABILITY CALCULATIONS FOR THE PROPOSED CONSTRUCTION OF STILT +4 FLOORS+5 TH FLOOR (PART)(18.M HEIGHT) RESIDENTIAL BUILDING WITH 14 DWELLING UNITS AT DOOR NO.19/2,PLOT NO. 20&21,CANAL ROAD,KAMARAJ NAGAR,THIRUVANMIYUR,CHENNAI-600041 COMPRISED IN OLD S.NO.37/1A1A,T. S. NO.89/2,BLOCK NO.11 ,WARD-1 OF THIRUVANMIYUR VILLAGE,VELACHERY TALUK WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION,ZONE-13,DIVISION-18

COLUMN DESIGN:

As per IS 13920:1993 Clause 7.1.2 ,
The minimum dimension of column shall not be less than 200 mm.
For the columns with unsupported length exceeding 4 m ,
the shortest dimension of the column shall not be less than 300 mm.
As per IS 13920:1993 Clause 7.1.3 of IS 13920:1993,
The ratio of the sohrtest cross sectional dimensions to the perpendicular dimension shall preferably not be less than 0.4.

Terms Used In Calculation :

In biaxial column design,

$P_u = P_{uc} + P_{us(Total)}$

where,

P_u = external axial compressive load,

P_{uc} = axial compressive resistance offered by concrete,

$P_{us(Total)}$ = total axial compressive resistance offered by steel at different levels in the section.

$M_u = M_{uc} + M_{us(Total)}$

where,

M_u = external moment about centroidal axis,

M_{uc} = moment of resistance offered by concrete in compression,

$M_{us(Total)}$ = total moment of resistance offered by steel at different levels in the section.

i = serial no. of row of reinforcement,

A_{si} = cross-sectional area of reinforcement in the i th row,

f_{si} = stress in the reinforcement in the i th row (compression + ve, tension - ve),

f_{ci} = compressive stress in concrete at the level of i th row of reinforcement,

e_i = strain at the i th row of reinforcement from the stress-strain curve of steel and concrete,

x_i = distance of the bars in the i th row from the centroid of the section

Values of stress in steel :

Design strength in bending compression (f_{yd}) = 0.87 f_y

(a) Fe 250,

For $e_i >= f_{yd} / E_s$, $f_{si} = f_{yd}$

For $e_i < f_{yd} / E_s$, $f_{si} = e_i \times f_{yd}$

(b) Fe 415,

For $e_i >= 0.8 \times f_{yd} / E_s$, f_{si} = value obtained from stress-strain curve

For $e_i < 0.8 \times f_{yd} / E_s$, $f_{si} = e_i \times f_{yd}$

Stress	Stress level (N/mmB)	Strain
0.800 f_{yd}	288.7	0.00144
0.850 f_{yd}	306.7	0.00163
0.900 f_{yd}	324.8	0.00192
0.950 f_{yd}	342.8	0.00241
0.975 f_{yd}	351.8	0.00276
1.000 f_{yd}	360.9	0.00380

Values of stress in concrete :

For $e_i >= 0.002$, $f_{ci} = 0.446\ f_{ck}$

For $e_i < 0.002$, $f_{ci} = (446.e_i \times (1 - 250.e_i)) \times f_{ck}$

Values of strain :

Values of strain at different levels are obtained by taking maximum strain as 0.0035 as the reference value at the highly compressed edge.

Transverse Reinforcement:

As per IS 13920 : 1993,the design shear force for columns shall be the maximum of

i)calculated factored shear force as per analysis, and

ii)a factored shear force given by

Vu = 1.4 x (MubL,lim + MubR,lim)/storey height

where MubL,lim,MubR,lim are moments of resistance,of oppsite sign framing into the column from oppsite faces (to be calculated as per IS 456 : 1978)

Design of CG1 :

General Design Parameters :

Below FIF FLOOR - Default Level at 21.000 m

Column size, (B x D)	= 450 x 230 mm	Column height,(L)	= 2400 mm

From analysis results,loads on column

Axial load,(P) = 67.31 kN

MomentX,(M_x) = 16.34 kN-m

MomentY,(M_y) = 30.04 kN-m

f_{ck} = 25.00 N/mmB

f_y = 500.00 N/mmB

Load combination = 1.50 DL + 1.50 LL

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2400 x 1.000) / 230 = 10.43 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2400 x 1.000) / 450 = 5.33 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 1.346 kN.m

$M_{y\_MinEccen}$ = 1.346 kN.m

$M_x = max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 16.344 kN.m

$M_y = max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 30.045 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 16.34/67.31 = 243 mm
Actual $eccen_Y$ = M_y / P = 30.04/67.31 = 446 mm
$eccen_{XMin}$ = (L/500) + (D/30) = (2400/500) + (230/30) = 12 mm
$eccen_{XMin}$ = max(12,20)= 20 mm
$eccen_{YMin}$ = (L/500) + (B/30) = (2400/500) + (450/30) = 20 mm
$eccen_{YMin}$ = max(20,20) = 20 mm
$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(243,20) = 243 mm
$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(446,20) = 446 mm

As per IS 456: 2000 Clause 39.3,
when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(243 mm) > 0.05 x 450(23 mm)
and eccenY(446 mm) > 0.05 x 230(12 mm)
Hence the column will be designed as a column with biaxial moments.
Provided steel :
Provide #12 - 8 nos. (905 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	(f_{si} - f_{ci}) (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	452	0.00081	162.06	7.20	154.86	70.06	69	4.83
2	452	-0.00726	-434.80	0.00	-434.80	-196.70	-69	13.57
					Total	-126.64		18.41

X_{ux} = 60 mm $P_{uc} = C_1.f_{ck}.B.D$
C_1 = 0.36 k_u = 0.36 x 60/230 = 0.094
P_{uc} = 0.094 x 25.00 x 450 x 230
= 242.43 kN
P_{ux1} = P_{uc} + $P_{us(Total)}$
= 242.43 + (-126.64)
= 115.78 kN > P ,hence O.K.
M_{uc} = P_{uc}.(0.5.D - C_2.D)
C_2 = 0.416 k_u = 0.416 x 60/230

$= 0.108$

$M_{uc} = 242.43 \times (0.5 \times 230 - 0.108 \times 230) = 21.84$ kN-m

$M_{ux1} = M_{uc} + M_{us(Total)}$

$= 21.84 + (18.41)$

$= 40.25$ kN-m

For Y axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	226	0.00228	392.01	11.15	380.86	86.15	179	15.42
2	226	-0.00090	-179.32	0.00	-179.32	-40.56	60	-2.42
3	226	-0.00407	-433.76	0.00	-433.76	-98.11	-60	5.85
4	226	-0.00724	-434.80	0.00	-434.80	-98.35	-179	17.60
					Total	-150.88		36.46

$x_{uy} = 132$ mm $\quad P_{uc} = C_1.f_{ck}.B.D$

$C_1 = 0.36\ k_u = 0.36 \times 132/450 = 0.105$

$P_{uc} = 0.105 \times 25.00 \times 230 \times 450$

$= 272.45$ kN

$P_{uy1} = P_{uc} + P_{us(Total)}$

$= 272.45 + (-150.88)$

$= 121.57$ kN $> P$,hence O.K.

$M_{uc} = P_{uc}.(0.5.B - C_2.B)$

$C_2 = 0.416\ k_u = 0.416 \times 132/450$

$= 0.122$

$M_{uc} = 272.45 \times (0.5 \times 450 - 0.122 \times 450) = 46.38$ kN-m

$M_{uy1} = M_{uc} + M_{us(Total)}$

$= 46.38 + (36.46)$

$= 82.84$ kN-m

$P_u/P_{uz} = 0.045$

For $P_u/P_{uz} <= 0.2$, $\quad a_n = 1.0$

For $P_u/P_{uz} >= 0.8$, $\quad a_n = 2.0$

For P_u/P_{uz} = 0.045, a_n = 1.000

$((M_{ux} / M_{ux1})^{a_n}) + ((M_{uy}/M_{uy1})^{a_n})$

$= ((16.34/40.25)^{1.000}) + ((30.04/82.84)^{1.000})$

= 0.863 < 1.0,hence O.K.

Ties Details :

Load combination for ties design = 1.20 DL + 1.20 LL + 1.20 EQL X+

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 12/4 = 3 mm

ii)in no case less than = 6 mm

Required diameter = maximum of (3, 6) = 6 mm

Provide 8 mm diameter for ties.

(considering the requirement for shear)

Calculation of spacing of ties :

Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)

t_{auc} = 0.610 MPa for 0.87% steel

D = 1 + $(3.P_u/A_g.f_{ck>})$ but not exceeding 1.5 = 1.06

t_{auc}=

t_{auc} x D = 0.647 MPa

For X - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm

Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= 0.00 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 66.99 kN
V_{us}	= V_{ud} - V_{uc} = -66.99 kN

Stirrup legs assumed = 2

V_{umin} = 0.87 x f_{ys} x A_{sv} x d /s_{vmin}

= 0.87 x 500 x 101 x 406 /115 = 154389.34 N

= 154.39 kN

$V_{us} < V_{usmin}$

Spacing from min.shear R/F requirement = (0.87 x f_{ys} x a_{sv})/(0.4 x width)

= ((0.87 x 500.000 x 100.531)/(0.4 x 230.000))x (415.0/500.0f)

= 395 mm

Required spacing = min(395,115) = 115 mm

For Y - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm

Design shear force,(V_{ud}) = 0.00 kN(from analysis)

V_{ud} = 0.00 kN

Capacity of concrete,(V_{uc}) = tauc x Area = 66.99 kN

V_{us} = V_{ud} - V_{uc} = -66.99 kN

Stirrup legs assumed = 4

V_{umin} = 0.87 x f_{ys} x A_{sv} x d /s_{vmin}

= 0.87 x 500 x 201 x 186 /115 = 141460.19 N

= 141.46 kN

$V_{us} < V_{usmin}$

Spacing from min.shear R/F requirement = $(0.87 \times f_{ys} \times a_{sv})/(0.4 \times \text{width})$

= ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f)

= 403 mm

Required spacing = min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 0.514 N/mm2
Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2
Actual Axial Stress is less than Allowable Axial Stress,
Hence, No need to provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

SUMMARY :

CG1 : FIF FLOOR - Default Level at 21.000 m
Provide rectangular section : 450 x 230 mm Provide #12 - 8 nos. (905 mmB) Provide ties #8 @ 110 mm c/c Provide 2 legged ties along width and 4 legged ties along depth.

General Design Parameters :

Below FO.FLOOR - Default Level at 18.000 m

Column size, (B x D) = 450 x 230 mm Column height,(L) = 2400 mm

From analysis results,loads on column

Axial load,(P) = 180.03 kN

MomentX,(M_x) = 25.55 kN-m

MomentY,(M_y) = 19.08 kN-m

f_{ck} = 25.00 N/mmB

f_y = 500.00 N/mmB

Load combination = 1.50 DL + 1.50 EQL Y-

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2400 x 1.000) / 230 = 10.43 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2400 x 1.000) / 450 = 5.33 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 3.601 kN.m
$M_{y\_MinEccen}$ = 3.601 kN.m
$M_x = \max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 25.549 kN.m
$M_y = \max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 19.077 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 25.55/180.03 = 142 mm
Actual $eccen_Y$ = M_y / P = 19.08/180.03 = 106 mm
$eccen_{XMin}$ = (L/500) + (D/30) = (2400/500) + (230/30) = 12 mm
$eccen_{XMin}$ = max(12,20)= 20 mm
$eccen_{YMin}$ = (L/500) + (B/30) = (2400/500) + (450/30) = 20 mm
$eccen_{YMin}$ = max(20,20) = 20 mm
$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(142,20) = 142 mm
$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(106,20) = 106 mm

As per IS 456: 2000 Clause 39.3,
when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(142 mm) > 0.05 x 450(23 mm)
and eccenY(106 mm) > 0.05 x 230(12 mm)
Hence the column will be designed as a column with biaxial moments.

Provided steel :
Provide #12 - 8 nos. (905 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	452	0.00143	285.66	10.24	275.43	124.60	69	8.60
2	452	-0.00479	-434.80	0.00	-434.80	-196.70	-69	13.57
					Total	-72.10		22.17

x_{ux} = 78 mm $\quad\quad P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 78/230 = 0.122

P_{uc} = 0.122 x 25.00 x 450 x 230

= 314.75 kN

$P_{ux1} = P_{uc} + P_{us(Total)}$

= 314.75 + (-72.10)

= 242.65 kN > P ,hence O.K.

$M_{uc} = P_{uc}.(0.5.D - C_2.D)$

C_2 = 0.416 k_u = 0.416 x 78/230

= 0.141

M_{uc} = 314.75 x (0.5 x 230 - 0.141 x 230) = 26.02 kN-m

$M_{ux1} = M_{uc} + M_{us(Total)}$

= 26.02 + (22.17)

= 48.19 kN-m

For Y axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	226	0.00254	403.25	11.15	392.10	88.69	179	15.88
2	226	0.00005	10.58	0.58	10.00	2.26	60	0.13
3	226	-0.00244	-398.75	0.00	-398.75	-90.20	-60	5.38
4	226	-0.00492	-434.80	0.00	-434.80	-98.35	-179	17.60

Total	-97.59		39.00

x_{uy} = 168 mm $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 168/450 = 0.134

P_{uc} = 0.134 x 25.00 x 230 x 450

= 347.49 kN

$P_{uy1} = P_{uc} + P_{us(Total)}$

= 347.49 + (-97.59)

= 249.90 kN > P ,hence O.K.

$M_{uc} = P_{uc}.(0.5.B - C_2.B)$

C_2 = 0.416 k_u = 0.416 x 168/450

= 0.155

M_{uc} = 347.49 x (0.5 x 450 - 0.155 x 450) = 53.92 kN-m

$M_{uy1} = M_{uc} + M_{us(Total)}$

= 53.92 + (39.00)

= 92.92 kN-m

P_u/P_{uz} = 0.121

For P_u/P_{uz} <= 0.2, a_n = 1.0

For P_u/P_{uz} >= 0.8, a_n = 2.0

For P_u/P_{uz} = 0.121, a_n = 1.000

$((M_{ux} / M_{ux1})^{a}{}_{n}) + ((M_{uy}/M_{uy1})^{a}{}_{n})$

= $((25.55/48.19)^{1.000}) + ((19.08/92.92)^{1.000})$

= 0.825 < 1.0,hence O.K.

Ties Details :

Load combination for ties design = 1.50 DL + 1.50 EQL X-

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 12/4 = 3 mm

ii)in no case less than = 6 mm

Required diameter = maximum of (3, 6) = 6 mm

Provide 8 mm diameter for ties.

(considering the requirement for shear)

Calculation of spacing of ties :

Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)

t_{auc} = 0.610 MPa for 0.87% steel

$D = 1 + (3.P_u/A_g.f_{ck>})$ but not exceeding 1.5 = 1.21
t_{auc}=
t_{auc} x D = 0.737 MPa
For X - axis :
As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:
i) the least lateral dimension of the compression member = 230 mm
ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied
= 16 x 12 = 192 mm
iii) 300 mm
Required spacing = minimum of (230, 192, 300) = 192 mm
Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm
Required spacing = minimum of (192, 115)= 115 mm

Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= 0.00 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 76.25 kN
V_{us}	= V_{ud} - V_{uc} = -76.25 kN

Stirrup legs assumed	= 2
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 101 x 406 /115 = 154389.34 N
	= 154.39 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 100.531)/(0.4 x 230.000))x (415.0/500.0f)
	= 395 mm
Required spacing	= min(395,115) = 115 mm

For Y - axis :
As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm

Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= 0.00 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 76.25 kN
V_{us}	= V_{ud} - V_{uc} = -76.25 kN
Stirrup legs assumed	= 4
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 201 x 186 /115 = 141460.19 N
	= 141.46 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f)
	= 403 mm
Required spacing	= min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 1.735 N/mm2

Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2

Actual Axial Stress is less than Allowable Axial Stress,

Hence, No need to provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

SUMMARY :

CG1 : FO.FLOOR - Default Level at 18.000 m

Provide rectangular section : 450 x 230 mm
Provide #12 - 8 nos. (905 mmB)
Provide ties #8 @ 110 mm c/c
Provide 2 legged ties along width and
4 legged ties along depth.

General Design Parameters :

Below TH FLOOR - Default Level at 15.000 m

Column size, (B x D) = 450 x 230 mm   Column height,(L) = 2400 mm

From analysis results,loads on column

Axial load,(P) = 312.21 kN

MomentX,(M_x) = 32.49 kN-m

MomentY,(M_y) = 15.90 kN-m

f_{ck} = 25.00 N/mmB

f_y = 500.00 N/mmB

Load combination = 1.50 DL + 1.50 EQL Y-

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2400 x 1.000) / 230 = 10.43 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2400 x 1.000) / 450 = 5.33 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 6.244 kN.m

$M_{y\_MinEccen}$ = 6.244 kN.m

$M_x = \max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 32.489 kN.m

$M_y = \max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 15.901 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 32.49/312.21 = 104 mm

Actual $eccen_Y$ = M_y / P = 15.90/312.21 = 51 mm

$eccen_{XMin}$ = (L/500) + (D/30) = (2400/500) + (230/30) = 12 mm

$eccen_{XMin}$ = max(12,20)= 20 mm

$eccen_{YMin}$ = (L/500) + (B/30) = (2400/500) + (450/30) = 20 mm

$eccen_{YMin}$ = max(20,20) = 20 mm

$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(104,20) = 104 mm

$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(51,20) = 51 mm

As per IS 456: 2000 Clause 39.3,
when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(104 mm) > 0.05 x 450(23 mm)
and eccenY(51 mm) > 0.05 x 230(12 mm)
Hence the column will be designed as a column with biaxial moments.
Provided steel :
Provide #12 - 8 nos. (905 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	452	0.00195	369.44	11.14	358.30	162.09	69	11.18
2	452	-0.00271	-410.28	0.00	-410.28	-185.61	-69	12.81
					Total	-23.51		23.99

x_{ux} = 104 mm $\quad\quad P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 104/230 = 0.162

P_{uc} = 0.162 x 25.00 x 450 x 230

= 420.27 kN

$P_{ux1} = P_{uc} + P_{us(Total)}$

$= 420.27 + (-23.51)$

$= 396.75$ kN > P ,hence O.K.

$M_{uc} = P_{uc}.(0.5.D - C_2.D)$

$C_2 = 0.416\ k_u = 0.416 \times 104/230$

$= 0.188$

$M_{uc} = 420.27 \times (0.5 \times 230 - 0.188 \times 230) = 30.19$ kN-m

$M_{ux1} = M_{uc} + M_{us(Total)}$

$= 30.19 + (23.99)$

$= 54.18$ kN-m

For Y axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	226	0.00273	411.17	11.15	400.02	90.48	179	16.20
2	226	0.00072	144.39	6.60	137.80	31.17	60	1.86
3	226	-0.00128	-256.63	0.00	-256.63	-58.05	-60	3.46
4	226	-0.00329	-425.65	0.00	-425.65	-96.28	-179	17.23
					Total	-32.68		38.75

$x_{uy} = 208$ mm $\qquad P_{uc} = C_1.f_{ck}.B.D$

$C_1 = 0.36\ k_u = 0.36 \times 208/450 = 0.167$

$P_{uc} = 0.167 \times 25.00 \times 230 \times 450$

$= 431.18$ kN

$P_{uy1} = P_{uc} + P_{us(Total)}$

$= 431.18 + (-32.68)$

$= 398.51$ kN > P ,hence O.K.

$M_{uc} = P_{uc}.(0.5.B - C_2.B)$

$C_2 = 0.416\ k_u = 0.416 \times 208/450$

$= 0.193$

$M_{uc} = 431.18 \times (0.5 \times 450 - 0.193 \times 450) = 59.65$ kN-m

$M_{uy1} = M_{uc} + M_{us(Total)}$

$= 59.65 + (38.75)$

$= 98.41$ kN-m

P_u/P_{uz} = 0.209

For P_u/P_{uz} <= 0.2, $a_n = 1.0$

For P_u/P_{uz} >= 0.8, $a_n = 2.0$

For P_u/P_{uz} = 0.209, $a_n = 1.079$

$((M_{ux} / M_{ux1})^{a_n}) + ((M_{uy}/M_{uy1})^{a_n})$

$= ((32.49/54.18)^{1.079}) + ((15.90/98.41)^{1.079})$

$= 0.814 < 1.0$,hence O.K.

Ties Details :

Load combination for ties design = 1.50 DL + 1.50 EQL Y-

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or
lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 12/4 = 3 mm

ii)in no case less than = 6 mm

Required diameter = maximum of (3, 6) = 6 mm

Provide 8 mm diameter for ties.

(considering the requirement for shear)

Calculation of spacing of ties :

$V_u = 1.4 \times (M_{ubL,lim} + M_{ubR,lim})$ / storey height

Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)

t_{auc} = 0.610 MPa for 0.87% steel

$D = 1 + (3.P_u/A_g.f_{ck>})$ but not exceeding 1.5 = 1.36

t_{auc}=

$t_{auc} \times D$ = 0.830 MPa

For X - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm

V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 85.95 kN
V_{us}	= V_{ud} - V_{uc} = 28.50 kN

Stirrup legs assumed	= 2
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 101 x 406 /115 = 154389.34 N
	= 154.39 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 100.531)/(0.4 x 230.000))x (415.0/500.0f)
	= 395 mm
Required spacing	= min(395,115) = 115 mm

For Y - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm

V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 85.95 kN
V_{us}	= V_{ud} - V_{uc} = 28.50 kN
Stirrup legs assumed	= 4
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 201 x 186 /115 = 141460.19 N
	= 141.46 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f)
	= 403 mm
Required spacing	= min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 3.016 N/mm2
Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2
Actual Axial Stress is greater than Allowable Axial Stress,
Hence, Provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

Confinement reinforcement :

Area of concrete core,(A_k)	
Size of concrete core,(B-core x D-core)	= (B - 2 x cover + 2 x dia.of Ties) x (D - 2 x cover + 2 x dia.of Ties)
	= (450 - 2 x 40 + 2 x 12) x (230 - 2 x 40 + 2 x 12)
	= 394 x 174
	= 68556 mmB
Maximum hoop length,(h)	= 197 mm

As per IS 13920 : 1993 , the spacing shall not exceed the smaller of

i) 1/4 th of the minimum member dimension = 230/4 = 58 mm

ii) 100 mm

Spacing need not be less than 75 mm

Required Spacing,(S) = 75 mm ~ 75 mm

Gross Area,(A_g) = 103500 mmB

C/S area of hoop bar,(A_{sh}) = 0.18 x S x h x f_{ck}/f_{ys} x ((A_g/A_k) - 1)

= 68 mmB

As per IS 13920 : 1993 , the length for confining reinforcement shall not be less than

i) larger lateral dimension of the member at the section where yielding occurs = 450 mm

ii) 1/6 th of the clear span of the member = 400 mm

iii) 450 mm

Length = 450 ~ 450 mm

Provide confinement reinforcement for 450 mm at both the junctions.

SUMMARY :

CG1 : TH FLOOR - Default Level at 15.000 m
Provide rectangular section : 450 x 230 mm
Provide #12 - 8 nos. (905 mmB)
Provide confinement reinforcement #12 @ 75mm c/c for a length 450mm on both ends of column.
Provide ties #8 @ 110 mm c/c for remaining length of the column
Provide 2 legged ties along width and 4 legged ties along depth.

General Design Parameters :

Below S FLOOR - Default Level at 12.000 m

Column size, (B x D) = 450 x 230 mm Column height,(L) = 2400 mm

From analysis results,loads on column

Axial load,(P) = 450.68 kN

MomentX,(M_x) = 37.59 kN-m

MomentY,(M_y) = 12.84 kN-m

f_{ck} = 25.00 N/mmB

f_y = 500.00 N/mmB

Load combination = 1.50 DL + 1.50 EQL Y-

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2400 x 1.000) / 230 = 10.43 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2400 x 1.000) / 450 = 5.33 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 9.014 kN.m
$M_{y\_MinEccen}$ = 9.014 kN.m
$M_x = \max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 37.587 kN.m
$M_y = \max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 12.843 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 37.59/450.68 = 83 mm
Actual $eccen_Y$ = M_y / P = 12.84/450.68 = 28 mm
$eccen_{XMin}$ = (L/500) + (D/30) = (2400/500) + (230/30) = 12 mm
$eccen_{XMin}$ = max(12,20)= 20 mm
$eccen_{YMin}$ = (L/500) + (B/30) = (2400/500) + (450/30) = 20 mm
$eccen_{YMin}$ = max(20,20) = 20 mm
$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(83,20) = 83 mm
$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(28,20) = 28 mm

As per IS 456: 2000 Clause 39.3,

when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(83 mm) > 0.05 x 450(23 mm)
and eccenY(28 mm) > 0.05 x 230(12 mm)
Hence the column will be designed as a column with biaxial moments.
Provided steel :
Provide #12 - 8 nos. (905 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	452	0.00225	390.38	11.15	379.23	171.56	69	11.84
2	452	-0.00151	-302.52	0.00	-302.52	-136.86	-69	9.44
					Total	34.70		21.28

x_{ux} = 128 mm $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 128/230 = 0.201

P_{uc} = 0.201 x 25.00 x 450 x 230
= 520.33 kN

P_{ux1} = P_{uc} + $P_{us(Total)}$
= 520.33 + (34.70)
= 555.03 kN > P ,hence O.K.

M_{uc} = P_{uc}.(0.5.D - C_2.D)

C_2 = 0.416 k_u = 0.416 x 128/230
= 0.232

M_{uc} = 520.33 x (0.5 x 230 - 0.232 x 230) = 32.03 kN-m

M_{ux1} = M_{uc} + $M_{us(Total)}$
= 32.03 + (21.28)
= 53.31 kN-m

For Y axis :

Row No.	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-

(i)								m)
1	226	0.00286	415.79	11.15	404.64	91.53	179	16.38
2	226	0.00120	239.58	9.36	230.23	52.08	60	3.11
3	226	-0.00046	-92.73	0.00	-92.73	-20.98	-60	1.25
4	226	-0.00213	-381.87	0.00	-381.87	-86.38	-179	15.46
					Total	36.25		36.20

x_{uy} = 251 mm $\quad\quad$ $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 251/450 = 0.201

P_{uc} = 0.201 x 25.00 x 230 x 450

= 520.33 kN

$P_{uy1} = P_{uc} + P_{us(Total)}$

= 520.33 + (36.25)

= 556.58 kN > P ,hence O.K.

$M_{uc} = P_{uc}.(0.5.B - C_2.B)$

C_2 = 0.416 k_u = 0.416 x 251/450

= 0.232

M_{uc} = 520.33 x (0.5 x 450 - 0.232 x 450) = 62.66 kN-m

$M_{uy1} = M_{uc} + M_{us(Total)}$

= 62.66 + (36.20)

= 98.87 kN-m

P_u/P_{uz} = 0.302

For P_u/P_{uz} <= 0.2, a_n = 1.0

For P_u/P_{uz} >= 0.8, a_n = 2.0

For P_u/P_{uz} = 0.302, a_n = 1.262

$((M_{ux} / M_{ux1})^{a_n}) + ((M_{uy}/M_{uy1})^{a_n})$

$= ((37.59/53.31)^{1.262}) + ((12.84/98.87)^{1.262})$

= 0.845 < 1.0,hence O.K.

Ties Details :

Load combination for ties design = 0.90 DL + 1.50 EQL Y-

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 12/4 = 3 mm

ii)in no case less than = 6 mm
Required diameter = maximum of (3, 6) = 6 mm
Provide 8 mm diameter for ties.
(considering the requirement for shear)

Calculation of spacing of ties :

V_u = 1.4 x ($M_{ubL,lim}$ + $M_{ubR,lim}$) / storey height
Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)
t_{auc} = 0.610 MPa for 0.87% steel
D = 1 + (3.P_u/A_g.$f_{ck>}$) but not exceeding 1.5 = 1.34
t_{auc}=
t_{auc} x D = 0.816 MPa
For X - axis :
As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:
i) the least lateral dimension of the compression member = 230 mm
ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied
= 16 x 12 = 192 mm
iii) 300 mm
Required spacing = minimum of (230, 192, 300) = 192 mm
Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm
Required spacing = minimum of (192, 115)= 115 mm
V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u = 114.45 kN
Design shear force,(V_{ud}) = 0.00 kN(from analysis)
V_{ud} = max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc}) = tauc x Area = 84.46 kN
V_{us} = V_{ud} - V_{uc} = 29.99 kN

Stirrup legs assumed = 2
V_{umin} = 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
= 0.87 x 500 x 101 x 406 /115 = 154389.34 N
= 154.39 kN

V_{us} < V_{usmin}

Spacing from min.shear R/F requirement	$= (0.87 \times f_{ys} \times a_{sv})/(0.4 \times width)$
	$= ((0.87 \times 500.000 \times 100.531)/(0.4 \times 230.000)) \times (415.0/500.0f)$
	= 395 mm
Required spacing	= min(395,115) = 115 mm

For Y - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm

V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	$= \max(V_{ud},V_u)$ = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 84.46 kN
V_{us}	$= V_{ud} - V_{uc}$ = 29.99 kN
Stirrup legs assumed	= 4
V_{umin}	$= 0.87 \times f_{ys} \times A_{sv} \times d / s_{vmin}$
	= 0.87 x 500 x 201 x 186 /115 = 141460.19 N
	= 141.46 kN

$V_{us} < V_{usmin}$

Spacing from min.shear R/F requirement	$= (0.87 \times f_{ys} \times a_{sv})/(0.4 \times width)$

	= ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f)
	= 403 mm
Required spacing	= min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 2.820 N/mm2
Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2
Actual Axial Stress is greater than Allowable Axial Stress,
Hence, Provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

Confinement reinforcement :

Area of concrete core,(A_k)	
Size of concrete core,(B-core x D-core)	= (B - 2 x cover + 2 x dia.of Ties) x (D - 2 x cover + 2 x dia.of Ties)
	= (450 - 2 x 40 + 2 x 12) x (230 - 2 x 40 + 2 x 12)
	= 394 x 174
	= 68556 mmB
Maximum hoop length,(h)	= 197 mm

As per IS 13920 : 1993 , the spacing shall not exceed the smaller of

i) 1/4 th of the minimum member dimension = 230/4 = 58 mm
ii) 100 mm

Spacing need not be less than 75 mm

Required Spacing,(S)	= 75 mm ~ 75 mm
Gross Area,(A_g)	= 103500 mmB
C/S area of hoop bar,(A_{sh})	= 0.18 x S x h x f_{ck}/f_{ys} x ((A_g/A_k) - 1)
	= 68 mmB

As per IS 13920 : 1993 , the length for confining reinforcement shall not be less than

i) larger lateral dimension of the member at the section where yielding occurs = 450 mm
ii) 1/6 th of the clear span of the member = 400 mm
iii) 450 mm

Length = 450 ~ 450 mm
Provide confinement reinforcement for 450 mm at both the junctions.

SUMMARY :

CG1 : S FLOOR - Default Level at 12.000 m
Provide rectangular section : 450 x 230 mm Provide #12 - 8 nos. (905 mmB) Provide confinement reinforcement #12 @ 75mm c/c for a length 450mm on both ends of column. Provide ties #8 @ 110 mm c/c for remaining length of the column Provide 2 legged ties along width and 4 legged ties along depth.

General Design Parameters :

Below F FLOOR - Default Level at 9.000 m

Column size, (B x D)	=	450 x 230 mm	Column height,(L)	=	2400 mm

From analysis results,loads on column

Axial load,(P) = 592.71 kN

MomentX,(M_x) = 40.66 kN-m

MomentY,(M_y) = 10.31 kN-m

f_{ck} = 25.00 N/mmB

f_y = 500.00 N/mmB

Load combination = 1.50 DL + 1.50 EQL Y-

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2400 x 1.000) / 230 = 10.43 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2400 x 1.000) / 450 = 5.33 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 11.854 kN.m

$M_{y\_MinEccen}$ = 11.854 kN.m

$M_x = \max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 40.656 kN.m

$M_y = \max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 11.854 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 40.66/592.71 = 69 mm

Actual $eccen_Y$ = M_y / P = 10.31/592.71 = 17 mm

$eccen_{XMin}$ = (L/500) + (D/30) = (2400/500) + (230/30) = 12 mm

$eccen_{XMin}$ = max(12,20)= 20 mm

$eccen_{YMin}$ = (L/500) + (B/30) = (2400/500) + (450/30) = 20 mm

$eccen_{YMin}$ = max(20,20) = 20 mm

$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(69,20) = 69 mm

$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(17,20) = 20 mm

As per IS 456: 2000 Clause 39.3,
when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(69 mm) > 0.05 x 450(23 mm)
and eccenY(20 mm) > 0.05 x 230(12 mm)

Hence the column will be designed as a column with biaxial moments.

Provided steel :
Provide #12 - 2 nos. + #16 - 4 nos. (1030 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	515	0.00237	395.84	11.15	384.69	198.20	67	13.28
2	515	-	-159.40	0.00	-159.40	-82.13	-67	5.50

		0.00080						
					Total	116.07		18.78

x_{ux} = 148 mm $\qquad$ $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 148/230 = 0.232

P_{uc} = 0.232 x 25.00 x 450 x 230

= 600.38 kN

P_{ux1} = P_{uc} + $P_{us(Total)}$

= 600.38 + (116.07)

= 716.45 kN > P ,hence O.K.

M_{uc} = $P_{uc}.(0.5.D - C_2.D)$

C_2 = 0.416 k_u = 0.416 x 148/230

= 0.268

M_{uc} = 600.38 x (0.5 x 230 - 0.268 x 230) = 32.02 kN-m

M_{ux1} = M_{uc} + $M_{us(Total)}$

= 32.02 + (18.78)

= 50.80 kN-m

For Y axis :

Row No. (i)	**A_{si} (mmB)**	**e_i**	**f_{si} (N/mmB)**	**f_{ci} (N/mmB)**	**(f_{si} - f_{ci}) (N/mmB)**	**P_{usi} (kN)**	**x_i (mm)**	**M_{usi} (kN-m)**
1	402	0.00293	418.12	11.15	406.97	163.65	177	28.97
2	226	0.00085	169.82	7.46	162.36	36.73	0	0.00
3	402	-0.00124	-247.25	0.00	-247.25	-99.43	-177	17.60
					Total	100.95		46.56

x_{uy} = 297 mm $\qquad$ $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 297/450 = 0.238

P_{uc} = 0.238 x 25.00 x 230 x 450

= 614.94 kN

P_{uy1} = P_{uc} + $P_{us(Total)}$

= 614.94 + (100.95)

= 715.89 kN > P ,hence O.K.

M_{uc} = $P_{uc}.(0.5.B - C_2.B)$

C_2 = 0.416 k_u = 0.416 x 297/450

= 0.275

M_{uc} = 614.94 x (0.5 x 450 - 0.275 x 450) = 62.37 kN-m

M_{uy1} = M_{uc} + $M_{us(Total)}$

= 62.37 + (46.56)

= 108.93 kN-m

P_u/P_{uz} = 0.385

For P_u/P_{uz} <= 0.2, a_n = 1.0

For P_u/P_{uz} >= 0.8, a_n = 2.0

For P_u/P_{uz} = 0.385, a_n = 1.422

$((M_{ux} / M_{ux1})^{a_n}) + ((M_{uy}/M_{uy1})^{a_n})$

$= ((40.66/50.80)^{1.422}) + ((11.85/108.93)^{1.422})$

= 0.931 < 1.0,hence O.K.

Ties Details :

Load combination for ties design = 0.90 DL + 1.50 EQL Y-

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 16/4 = 4 mm

ii)in no case less than = 6 mm

Required diameter = maximum of (4, 6) = 6 mm

Provide 8 mm diameter for ties.

(considering the requirement for shear)

Calculation of spacing of ties :

V_u = 1.4 x ($M_{ubL,lim}$ + $M_{ubR,lim}$) / storey height

Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)

t_{auc} = 0.640 MPa for 1.00% steel

D = 1 + $(3.P_u/A_g.f_{ck>})$ but not exceeding 1.5 = 1.45

t_{auc}=

t_{auc} x D = 0.931 MPa

For X - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm
Required spacing = minimum of (192, 115)= 115 mm
V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 96.33 kN
V_{us}	= V_{ud} - V_{uc} = 18.11 kN
Stirrup legs assumed	= 2
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 101 x 406 /115 = 154389.34 N
	= 154.39 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 100.531)/(0.4 x 230.000))x (415.0/500.0f)
	= 395 mm
Required spacing	= min(395,115) = 115 mm

For Y - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied
= 16 x 12 = 192 mm

iii) 300 mm

Required spacing = minimum of (230, 192, 300) = 192 mm
Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (192, 115)= 115 mm
V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 96.33 kN
V_{us}	= V_{ud} - V_{uc} = 18.11 kN
Stirrup legs assumed	= 4
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin} = 0.87 x 500 x 201 x 186 /115 = 141460.19 N = 141.46 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width) = ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f) = 403 mm
Required spacing	= min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 3.779 N/mm2
Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2
Actual Axial Stress is greater than Allowable Axial Stress,
Hence, Provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

Confinement reinforcement :

Area of concrete core,(A_k)	
Size of concrete core,(B-core x D-core)	= (B - 2 x cover + 2 x dia.of Ties) x (D - 2 x cover + 2 x dia.of Ties) = (450 - 2 x 40 + 2 x 12) x (230 - 2 x 40 + 2 x 12) = 394 x 174

= 68556 mmB

Maximum hoop length,(h) = 197 mm

As per IS 13920 : 1993 , the spacing shall not exceed the smaller of

i) 1/4 th of the minimum member dimension = 230/4 = 58 mm

ii) 100 mm

Spacing need not be less than 75 mm

Required Spacing,(S) = 75 mm ~ 75 mm

Gross Area,(A_g) = 103500 mmB

C/S area of hoop bar,(A_{sh}) = 0.18 x S x h x f_{ck}/f_{ys} x ((A_g/A_k) - 1)

= 68 mmB

As per IS 13920 : 1993 , the length for confining reinforcement shall not be less than

i) larger lateral dimension of the member at the section where yielding occurs = 450 mm

ii) 1/6 th of the clear span of the member = 400 mm

iii) 450 mm

Length = 450 ~ 450 mm

Provide confinement reinforcement for 450 mm at both the junctions.

SUMMARY :

CG1 : F FLOOR - Default Level at 9.000 m
Provide rectangular section : 450 x 230 mm
Provide #12 - 2 nos. + #16 - 4 nos. (1030 mmB)
Provide confinement reinforcement
#12 @ 75mm c/c for a length
450mm on both ends of column.
Provide ties #8 @ 110 mm c/c
for remaining length of the column
Provide 2 legged ties along width and
4 legged ties along depth.

General Design Parameters :

Below G FLOOR - Default Level at 6.000 m

Column size, (B x D) = 450 x 230 mm   Column height,(L) = 2400 mm

From analysis results,loads on column

Axial load,(P) = 733.02 kN

MomentX,(M_x) = 40.41 kN-m
MomentY,(M_y) = 5.55 kN-m
f_{ck} = 25.00 N/mmB
f_y = 500.00 N/mmB
Load combination = 1.50 DL + 1.50 EQL Y-

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2400 x 1.000) / 230 = 10.43 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2400 x 1.000) / 450 = 5.33 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 14.660 kN.m
$M_{y\_MinEccen}$ = 14.660 kN.m
$M_x = \max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 40.406 kN.m
$M_y = \max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 14.660 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 40.41/733.02 = 55 mm
Actual $eccen_Y$ = M_y / P = 5.55/733.02 = 8 mm
$eccen_{XMin}$ = (L/500) + (D/30) = (2400/500) + (230/30) = 12 mm
$eccen_{XMin}$ = max(12,20)= 20 mm
$eccen_{YMin}$ = (L/500) + (B/30) = (2400/500) + (450/30) = 20 mm
$eccen_{YMin}$ = max(20,20) = 20 mm

$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(55,20) = 55 mm
$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(8,20) = 20 mm

As per IS 456: 2000 Clause 39.3,
when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(55 mm) > 0.05 x 450(23 mm)
and eccenY(20 mm) > 0.05 x 230(12 mm)
Hence the column will be designed as a column with biaxial moments.
Provided steel :
Provide #16 - 6 nos. (1206 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	**A_{si} (mmB)**	**e_i**	**f_{si} (N/mmB)**	**f_{ci} (N/mmB)**	**(f_{si} - f_{ci}) (N/mmB)**	**P_{usi} (kN)**	**x_i (mm)**	**M_{usi} (kN-m)**
1	603	0.00249	401.05	11.15	389.90	235.18	67	15.76
2	603	-0.00033	-66.50	0.00	-66.50	-40.11	-67	2.69
					Total	195.08		18.44

x_{ux} = 166 mm $P_{uc} = C_1.f_{ck}.B.D$
C_1 = 0.36 k_u = 0.36 x 166/230 = 0.260
P_{uc} = 0.260 x 25.00 x 450 x 230
= 673.15 kN
P_{ux1} = P_{uc} + $P_{us(Total)}$
= 673.15 + (195.08)
= 868.23 kN > P ,hence O.K.
M_{uc} = P_{uc}.(0.5.D - C_2.D)
C_2 = 0.416 k_u = 0.416 x 166/230
= 0.301
M_{uc} = 673.15 x (0.5 x 230 - 0.301 x 230) = 30.87 kN-m
M_{ux1} = M_{uc} + $M_{us(Total)}$
= 30.87 + (18.44)
= 49.31 kN-m

For Y axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	$(f_{si} - f_{ci})$ (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)
1	402	0.00299	419.90	11.15	408.75	164.37	177	29.09
2	402	0.00112	223.40	8.98	214.43	86.23	0	0.00
3	402	-0.00076	-151.52	0.00	-151.52	-60.93	-177	10.78
					Total	189.67		39.88

x_{uy} = 330 mm $\quad\quad$ $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 330/450 = 0.264

P_{uc} = 0.264 x 25.00 x 230 x 450

= 684.07 kN

$P_{uy1} = P_{uc} + P_{us(Total)}$

= 684.07 + (189.67)

= 873.74 kN > P ,hence O.K.

$M_{uc} = P_{uc}.(0.5.B - C_2.B)$

C_2 = 0.416 k_u = 0.416 x 330/450

= 0.306

M_{uc} = 684.07 x (0.5 x 450 - 0.306 x 450) = 59.87 kN-m

$M_{uy1} = M_{uc} + M_{us(Total)}$

= 59.87 + (39.88)

= 99.75 kN-m

P_u/P_{uz} = 0.457

For P_u/P_{uz} <= 0.2, $\quad a_n$ = 1.0

For P_u/P_{uz} >= 0.8, $\quad a_n$ = 2.0

For P_u/P_{uz} = 0.457, a_n = 1.556

$((M_{ux} / M_{ux1})^{a_n}) + ((M_{uy}/M_{uy1})^{a_n})$

= ((40.41/49.31)$^{1.556}$) + ((14.66/99.75)$^{1.556}$)

= 0.962 < 1.0,hence O.K.

Ties Details :

Load combination for ties design = 0.90 DL + 1.50 EQL Y-

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or
lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 16/4 = 4 mm

ii)in no case less than = 6 mm

Required diameter = maximum of (4, 6) = 6 mm

Provide 8 mm diameter for ties.

(considering the requirement for shear)

Calculation of spacing of ties :

V_u = 1.4 x ($M_{ubL,lim}$ + $M_{ubR,lim}$) / storey height

Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)

t_{auc} = 0.679 MPa for 1.17% steel

D = 1 + (3.P_u/A_g.$f_{ck>}$) but not exceeding 1.5 = 1.50

t_{auc}=

t_{auc} x D = 1.018 MPa

For X - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 16 = 256 mm

iii) 300 mm

Required spacing = minimum of (230, 256, 300) = 230 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (230, 115)= 115 mm

V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 105.36 kN
V_{us}	= V_{ud} - V_{uc} = 9.08 kN

Stirrup legs assumed	= 2
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 101 x 406 /115 = 154389.34 N
	= 154.39 kN

$V_{us} < V_{usmin}$

Spacing from min.shear R/F requirement	$= (0.87 \times f_{ys} \times a_{sv})/(0.4 \times \text{width})$
	= ((0.87 x 500.000 x 100.531)/(0.4 x 230.000))x (415.0/500.0f)
	= 395 mm
Required spacing	= min(395,115) = 115 mm

For Y - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 16 = 256 mm

iii) 300 mm

Required spacing = minimum of (230, 256, 300) = 230 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (230, 115)= 115 mm

V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	$= \max(V_{ud},V_u)$ = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 105.36 kN
V_{us}	$= V_{ud} - V_{uc}$ = 9.08 kN
Stirrup legs assumed	= 4
V_{umin}	$= 0.87 \times f_{ys} \times A_{sv} \times d / s_{vmin}$
	= 0.87 x 500 x 201 x 186 /115 = 141460.19 N
	= 141.46 kN

$V_{us} < V_{usmin}$

Spacing from min.shear R/F	$= (0.87 \times f_{ys} \times a_{sv})/(0.4 \times \text{width})$

requirement

= ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f)

= 403 mm

Required spacing = min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 4.752 N/mm2
Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2
Actual Axial Stress is greater than Allowable Axial Stress,
Hence, Provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

Confinement reinforcement :

Area of concrete core,(A_k)

Size of concrete core,(B-core x D-core) = (B - 2 x cover + 2 x dia.of Ties) x (D - 2 x cover + 2 x dia.of Ties)

= (450 - 2 x 40 + 2 x 12) x (230 - 2 x 40 + 2 x 12)

= 394 x 174

= 68556 mmB

Maximum hoop length,(h) = 197 mm

As per IS 13920 : 1993 , the spacing shall not exceed the smaller of

i) 1/4 th of the minimum member dimension = 230/4 = 58 mm

ii) 100 mm

Spacing need not be less than 75 mm

Required Spacing,(S) = 75 mm ~ 75 mm

Gross Area,(A_g) = 103500 mmB

C/S area of hoop bar,(A_{sh}) = 0.18 x S x h x f_{ck}/f_{ys} x ((A_g/A_k) - 1)

= 68 mmB

As per IS 13920 : 1993 , the length for confining reinforcement shall not be less than

i) larger lateral dimension of the member at the section where yielding occurs = 450 mm

ii) 1/6 th of the clear span of the member = 400 mm

iii) 450 mm

Length = 450 ~ 450 mm

Provide confinement reinforcement for 450 mm at both the junctions.

SUMMARY :

CG1 : G FLOOR - Default Level at 6.000 m Provide rectangular section : 450 x 230 mm Provide #16 - 6 nos. (1206 mmB) Provide confinement reinforcement #12 @ 75mm c/c for a length 450mm on both ends of column. Provide ties #8 @ 110 mm c/c for remaining length of the column Provide 2 legged ties along width and 4 legged ties along depth.

General Design Parameters :

Below basement - Default Level at 3.000 m

Column size, (B x D)	=	450 x 230 mm	Column height,(L)	=	2700 mm

From analysis results,loads on column

Axial load,(P) = 810.75 kN

MomentX,(M_x) = 33.14 kN-m

MomentY,(M_y) = 10.91 kN-m

f_{ck} = 25.00 N/mmB

f_y = 500.00 N/mmB

Load combination = 1.50 DL + 1.50 EQL Y-

Column Name	Orientation Angle
C1	0.00

Check For Slenderness :

Slenderness RatioX = (L_o x Effective Length FactorX) / Depth
= (2700 x 1.000) / 230 = 11.74 <= 12.00,

column is not slender in this direction.

Slenderness RatioY = (L_o x Effective Length FactorY) / Width
= (2700 x 1.000) / 450 = 6.00 <= 12.00,

column is not slender in this direction.

$M_{x\_MinEccen}$ = 16.215 kN.m
$M_{y\_MinEccen}$ = 16.539 kN.m
$M_x = \max(M_x, M_{x\_MinEccen}) + M_{uaddX}$ = 33.136 kN.m
$M_y = \max(M_y, M_{y\_MinEccen}) + M_{uaddY}$ = 16.539 kN.m

Calculation Of Eccentricities :

As per IS 456: 2000 Clause 25.4,all columns shall be designed for minimum eccentricity
equal to the unsupported length of the column/500 plus lateral dimension/30, subject to a minimum of 20 mm.

Actual $eccen_X$ = Mx / P = 33.14/810.75 = 41 mm
Actual $eccen_Y$ = M_y / P = 10.91/810.75 = 13 mm
$eccen_{XMin}$ = (L/500) + (D/30) = (2700/500) + (230/30) = 13 mm
$eccen_{XMin}$ = max(13,20)= 20 mm
$eccen_{YMin}$ = (L/500) + (B/30) = (2700/500) + (450/30) = 20 mm
$eccen_{YMin}$ = max(20,20) = 20 mm
$eccen_X$ = max(Actual $eccen_X$,$eccen_{XMin}$) = max(41,20) = 41 mm
$eccen_Y$ = max(Actual $eccen_Y$,$eccen_{YMin}$) = max(13,20) = 20 mm

As per IS 456: 2000 Clause 39.3,
when the minimum eccentricity does not exceed 0.05 times the lateral dimension,
the column will be designed as an axially loaded column.
eccenX(41 mm) > 0.05 x 450(23 mm)
and eccenY(20 mm) > 0.05 x 230(12 mm)
Hence the column will be designed as a column with biaxial moments.
Provided steel :
Provide #16 - 6 nos. (1206 mmB)

Biaxial Check Calculations :

For X axis :

Row No. (i)	A_{si} (mmB)	e_i	f_{si} (N/mmB)	f_{ci} (N/mmB)	(f_{si} - f_{ci}) (N/mmB)	P_{usi} (kN)	x_i (mm)	M_{usi} (kN-m)

1	603	0.00257	404.28	11.15	393.13	237.13	67	15.89
2	603	-0.00005	-9.01	0.00	-9.01	-5.43	-67	0.36
					Total	231.70		16.25

x_{ux} = 180 mm $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 180/230 = 0.281

P_{uc} = 0.281 x 25.00 x 450 x 230

= 727.73 kN

P_{ux1} = P_{uc} + $P_{us(Total)}$

= 727.73 + (231.70)

= 959.43 kN > P ,hence O.K.

M_{uc} = P_{uc}.(0.5.D - C_2.D)

C_2 = 0.416 k_u = 0.416 x 180/230

= 0.325

M_{uc} = 727.73 x (0.5 x 230 - 0.325 x 230) = 29.29 kN-m

M_{ux1} = M_{uc} + $M_{us(Total)}$

= 29.29 + (16.25)

= 45.54 kN-m

For Y axis :

Row No. (i)	**A_{si} (mmB)**	**e_i**	**f_{si} (N/mmB)**	**f_{ci} (N/mmB)**	**(f_{si} - f_{ci}) (N/mmB)**	**P_{usi} (kN)**	**x_i (mm)**	**M_{usi} (kN-m)**
1	402	0.00303	421.00	11.15	409.85	164.81	177	29.17
2	402	0.00128	256.44	9.71	246.72	99.21	0	0.00
3	402	-0.00046	-92.50	0.00	-92.50	-37.20	-177	6.58
					Total	226.83		35.76

x_{uy} = 355 mm $P_{uc} = C_1.f_{ck}.B.D$

C_1 = 0.36 k_u = 0.36 x 355/450 = 0.284

P_{uc} = 0.284 x 25.00 x 230 x 450

= 735.01 kN

P_{uy1} = P_{uc} + $P_{us(Total)}$

= 735.01 + (226.83)

= 961.84 kN > P ,hence O.K.

M_{uc} = P_{uc}.(0.5.B - C_2.B)

$C_2 = 0.416\ k_u = 0.416 \times 355/450$

$= 0.328$

$M_{uc} = 735.01 \times (0.5 \times 450 - 0.328 \times 450) = 56.81$ kN-m

$M_{uy1} = M_{uc} + M_{us(Total)}$

$= 56.81 + (35.76)$

$= 92.56$ kN-m

$P_u/P_{uz} = 0.506$

For $P_u/P_{uz} <= 0.2$, $a_n = 1.0$

For $P_u/P_{uz} >= 0.8$, $a_n = 2.0$

For $P_u/P_{uz} = 0.506$, $a_n = 1.651$

$((M_{ux} / M_{ux1})^{a_n}) + ((M_{uy}/M_{uy1})^{a_n})$

$= ((33.14/45.54)^{1.651}) + ((16.54/92.56)^{1.651})$

$= 0.812 < 1.0$,hence O.K.

Ties Details :

Load combination for ties design = 0.90 DL + 1.50 EQL Y-

Calculation of diameter of ties :

As per IS 456: 2000 Clause 26.5.3.2 (c),the diameter of the polygonal links or
lateral ties shall be not less than the following

i)one-fourth the diameter of the largest longitudinal bar = 16/4 = 4 mm

ii)in no case less than = 6 mm

Required diameter = maximum of (4, 6) = 6 mm

Provide 8 mm diameter for ties.

(considering the requirement for shear)

Calculation of spacing of ties :

$V_u = 1.4 \times (M_{ubL,lim} + M_{ubR,lim})$ / storey height

Calculation of t_{auc} (as per IS 456: 2000 Clause 40.2.2)

$t_{auc} = 0.679$ MPa for 1.17% steel

$D = 1 + (3.P_u/A_g.f_{ck>})$ but not exceeding 1.5 = 1.50

$t_{auc}=$

$t_{auc} \times D = 1.018$ MPa

For X - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be
not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 16 = 256 mm

iii) 300 mm

Required spacing = minimum of (230, 256, 300) = 230 mm

Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm

Required spacing = minimum of (230, 115)= 115 mm

V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 105.36 kN
V_{us}	= V_{ud} - V_{uc} = 9.08 kN
Stirrup legs assumed	= 2
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 101 x 406 /115 = 154389.34 N
	= 154.39 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 100.531)/(0.4 x 230.000))x (415.0/500.0f)
	= 395 mm
Required spacing	= min(395,115) = 115 mm

For Y - axis :

As per IS 456: 2000 , the pitch of transverse reinforcement shall be not more than the least of the following distances:

i) the least lateral dimension of the compression member = 230 mm

ii) sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied

= 16 x 16 = 256 mm

iii) 300 mm

Required spacing = minimum of (230, 256, 300) = 230 mm
Maximum ties spacing as per IS 13920 = the least lateral dimension/2 = 115 mm
Required spacing = minimum of (230, 115)= 115 mm
V_u for columns in the group :

Column.No	$M_{ubL,lim}$(kN-m)	$M_{ubR,lim}$(kN-m)	V_u(kN)
C1	245.24	0.00	114.45

V_u	= 114.45 kN
Design shear force,(V_{ud})	= 0.00 kN(from analysis)
V_{ud}	= max(V_{ud},V_u) = 114.45 kN
Capacity of concrete,(V_{uc})	= tauc x Area = 105.36 kN
V_{us}	= V_{ud} - V_{uc} = 9.08 kN

Stirrup legs assumed	= 4
V_{umin}	= 0.87 x f_{ys} x A_{sv} x d /s_{vmin}
	= 0.87 x 500 x 201 x 186 /115 = 141460.19 N
	= 141.46 kN
V_{us} < V_{usmin}	
Spacing from min.shear R/F requirement	= (0.87 x f_{ys} x a_{sv})/(0.4 x width)
	= ((0.87 x 500.000 x 201.062)/(0.4 x 450.000))x (415.0/500.0f)
	= 403 mm
Required spacing	= min(403,115) = 115 mm

Axial Stess Check :

Actual Axial Stress = 5.364 N/mm2
Allowable Axial Stress = 0.1 x fck = 2.500 N/mm2
Actual Axial Stress is greater than Allowable Axial Stress,
Hence, Provide Ductile detailing as per 7.1.1 clause,IS 13920

Provide ties #8 @ 110 mm c/c

Confinement reinforcement :

Area of concrete core,(A_k)	
Size of concrete core,(B-core x D-core)	= (B - 2 x cover + 2 x dia.of Ties) x (D - 2 x cover + 2 x dia.of Ties)

= (450 - 2 x 40 + 2 x 12) x (230 - 2 x 40 + 2 x 12)
= 394 x 174
= 68556 mmB

Maximum hoop length,(h) = 197 mm

As per IS 13920 : 1993 , the spacing shall not exceed the smaller of

i) 1/4 th of the minimum member dimension = 230/4 = 58 mm
ii) 100 mm

Spacing need not be less than 75 mm

Required Spacing,(S) = 75 mm ~ 75 mm

Gross Area,(A_g) = 103500 mmB

C/S area of hoop bar,(A_{sh}) = 0.18 x S x h x f_{ck}/f_{ys} x ((A_g/A_k) - 1)
= 68 mmB

As per IS 13920 : 1993 , the length for confining reinforcement shall not be less than

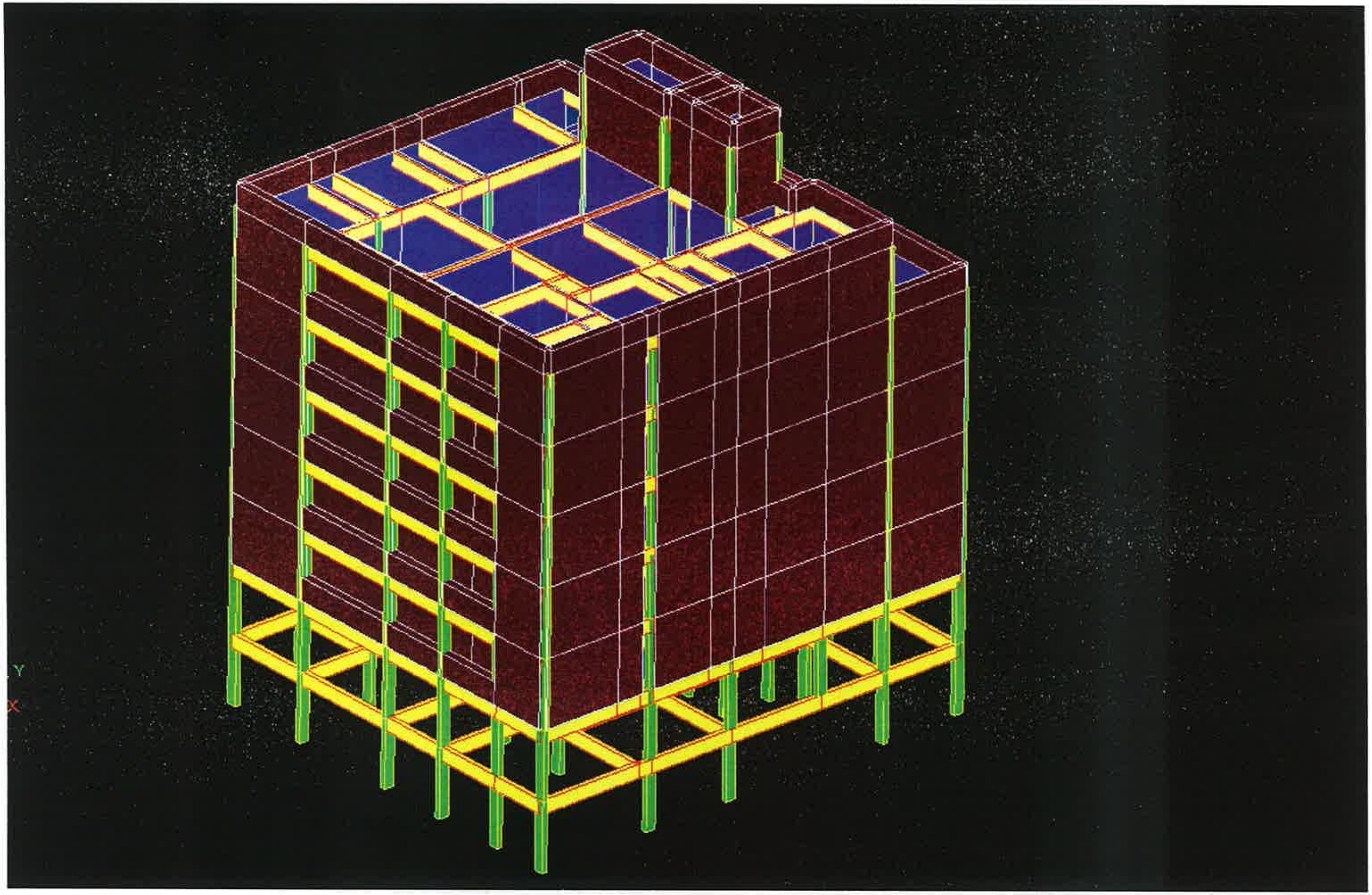
i) larger lateral dimension of the member at the section where yielding occurs = 450 mm
ii) 1/6 th of the clear span of the member = 450 mm
iii) 450 mm

Length = 450 ~ 450 mm

Provide confinement reinforcement for 450 mm at both the junctions.

SUMMARY :

CG1 : basement - Default Level at 3.000 m
Provide rectangular section : 450 x 230 mm
Provide #16 - 6 nos. (1206 mmB)
Provide confinement reinforcement
#12 @ 75mm c/c for a length
450mm on both ends of column.
Provide ties #8 @ 110 mm c/c
for remaining length of the column
Provide 2 legged ties along width and
4 legged ties along depth.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