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DATE: 29.10.25

STABILITY CERTIFICATE

(To be furnished while filing application for registration of building)

The detailed engineering and structure design of the proposed building comprising of Stilt Floor + 5 Floors (Height - 18.30m) Residential Apartment with 10 Dwelling units at Anna Nagar, Chennai – 600 050 comprised in Old.S.No.114/2pt,T.S.No.213,Block No.9-B,Ward No.1, Naduvakkarai Village within the Limits of Greater Chennai Corporation has been done by me/us based on the report of geotechnical investigation (soil test) done by NEO GEOCONS and considering the functional requirement of the building.

2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building would be safe.

3. I/We. Further certify that:

(i) The minimum grade of concrete is M25

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No IS 875 and design of earthquake resistant structure as per IS Code No IS 1893.

4. The building will be safe and sound when used for the purpose for which it is designed.

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PILECAP DESIGN CALCULATIONS

Project Name	:	PROPOSED RESIDENTIAL BUILDING AT CHENNAI
Client Name	:	GMS
Engineer Name	:	NSS
Design File	:	C:\WELCOME\GMS PILE.rcdx
Analysis File	:	G:\GMS -ANNA NAGAR-24.09.2025 rev .STD
Analysis Last Modified	:	9/24/2025 3:42:29 PM

Definitions:

1. α = Coefficient of Thermal Expansion
2. ε1 = Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
3. εm = Average steel strain at level considered
4. pact = Percentage steel provided
5. pcrit = Percentage steel critical as per code
6. A1 = Area of Base for Load Transfer
7. A2 = Area of Bearing under column
8. acr = Distance from the point considered to the surface of the nearest longitudinal bar
9. AsfrPrv = Area of face reinforcement provided
10. AsfrReq = Area of face reinforcement required
11. AstPrv = Area of tensile reinforcement provided
12. AstReq = Area of tensile reinforcement required
13. AsvPrv = Area of shear reinforcement provided
14. AsvReq = Area of shear reinforcement required
15. Av = Location of section of shear-check from Pile Center
16. Beff = Effective Width for design for bending and shear
17. Beffsfr = Effective Width for design for Face Reinforcement
18. BMux = Factored Bending Moment for pile-cap along column D
19. BMuy = Factored Bending Moment for pile-cap along column B
20. D = Depth of Pilecap
21. Deff = Effective Depth of Pilecap
22. DfCol = Distance of Pile center to face of column
23. Ec = Modulus of elasticity of concrete
24. Es = Modulus of elasticity of steel
25. Fst = Stress in steel
26. Mx = Bending Moment in column along Column D
27. My = Bending Moment in column along Column B
28. P = Axial load in pile due to Ptotal
29. Pcomb = Axial load in column for a load combination

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30. Ppile = Axial Load on pile
31. Ptotal = Total vertical load on pile-cap for a load combination
32. Pmx = Axial load on pile due to moment Mx
33. Pmy = Axial load on pile due to moment My
34. sp = Spacing Between bars at outer most layer
35. Tc = Design Shear Strength of Concrete
36. Tce = Enhanced Shear Strength of concrete
37. Temp1 = Peak Hydration temperature
38. Temp2 = Seasonal Temperature Variations
39. Tv = Nominal shear stress
40. Vu = Design shear force
41. Vus = Design shear force for stirrups
42. Wcr = Surface Crack Width

Code References:

IS 456

1. Ptmax : clause 26.5.1.1
2. Ptmin : clause 26.5.2.1
3. Pt : clause 38
4. Tc : clause 40.2.1
5. Tcmax : clause 40.2.3
6. AsvReq : clause 40.4
7. Min Shear Reinf : clause 26.5.1.6
8. Max Stirrup Spacing : clause 26.5.1.5
9. One Way Shear Criteria : clause 34.2.4.2
10. Load transfer : clause 34.4
11. Ptnominal : clause 34.5.2
12. crack width calculation : Annex-F
13. cracking : clause. 35.3.2

IS 2911 Part-1 Section 2

1. Pile capacity check : clause 5.10

BS 8007 (For Early / Initial Thermal Cracking)

1. Surface Zone for suspended slab : Figure A.1
2. Surface Zone for ground slab : Figure A.2
3. Factors for the calculation of minimum reinforcement : Table A.1

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Design Code	:	IS 456 + IS 13920 - 1993	
Pilecap No	:	PC1	
Column No	:	C1	(300mm X 600mm)
Member Ref. No	:	2	
Concrete Grade	:	M25	
Steel Grade	:	Fe500	
Clear Cover	:	50	mm
Top of pile-cap below ground	:	15.4	m
Density of Soil	=	18	kN/cum
Founding Depth	=	16	m
Pile Capacity in Compression	=	750	kN
Pile Capacity in Tension	=	229	kN
Pile Capacity in Shear	=	83	kN
Pile Capacity Reduction	=	0	%
Pile Overloading	=	10	%
Pile Group Overloading	=	10	%
Pile Capacity Increase for EQ	=	25	%
Pile Capacity Increase for Wind	=	25	%
Live Load Reduction	=	0	%
Consider Capacity Design	:	No	
Consider Overburden Pressure	:	No	
No. of Piles	=	2	
Pile Diameter	=	600	mm
Pilecap Offset	=	150	mm
Pile Spacing	=	2.5	x Ø
Pilecap Size	=	2400 X 900	mm
Pilecap Depth	=	600	mm
Pile-cap Wt.	=	32.4	kN

For design, moments along shorter direction of pile cap has been ignored

Check for Maximum Load on One Pile:

Critical Analysis Load Combination	:	20	
Critical Load Combination	:	[16] : (LOAD 3: DEAD LOAD) -(LOAD 1: EQX)	
Pcomb	=	572	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	604.4	kN
Mx	=	-65.23	kNm
My	=	-4.61	kNm

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P	=	Ptotal/ No. of Piles	
	=	302.2	kN
Pmx	=	43.49	kN
Pmy	=	0	kN
Maximum load on pile	=	345.69	kN
Allowable load on pile	=	750 x 1.25	
	=	937.5	kN

Check for Maximum Load on Pile Group:

Critical Analysis Load Combination	:	18	
Critical Load Combination	:	[14] : (LOAD 3: DEAD LOAD) +(LOAD 4: LIVE LOAD)	
Pcomb	=	444.15	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	476.55	kN
Mx	=	6.37	kNm
My	=	-5.11	kNm
Maximum load on pile group	=	476.55	kN
Allowable load on pile group	=	2 x 750 x 1.1	
	=	1650	kN

Check for Maximum shear on Pile Group:

Critical Analysis Load Combination	:	20	
Critical Load Combination	:	[16] : (LOAD 3: DEAD LOAD) -(LOAD 1: EQX)	
Pcomb	=	572	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	604.4	kN
Mx	=	-65.23	kNm
My	=	-4.61	kNm
Vx	=	10.29	kNm
Vy	=	-31.16	kNm
Maximum shear on pile group	=	$sqrt(10.29^2 + -31.16^2)$	
	=	32.81	kN
Shear capacity of pile group	=	2 x 83 x 1 x 1.25	
	=	207.5	kN

Check for Uplift Load on Pile:

No uplift in any pile

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Design for Bending:

Bottom Reinforcement Along Column-D

Critical Analysis Load Combination	:	7	
Critical Load Combination	:	[25] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 1: EQX)	
Pcomb	=	858	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	906.6	kN
Mx	=	-97.85	kNm
My	=	-6.92	kNm
Ppile	=	Max Load on pile	
	=	518.53	kN
Deff	=	540	mm
Beff	=	900	mm
DfCol	=	0.45	m
BMux	=	Ppile X DfCol	
	=	233.34	kNm
PtReq	=	0.21	%
AstReq (BM)	=	1153	sqmm/m
AstPrv	=	T16 @ 170 C/C	
	=	1183	sqmm/m

Top Reinforcement Along Column-D

D	=	600	mm
	<=	1000	mm, Hence
AstReq (BM)	=	Min Pt for Top Reinforcement X D X 1000	
	=	0.06% X 600 X 1000	
	=	360	sqmm/m
AstPrv	=	T10 @ 215 C/C	
	=	365	sqmm/m

Bottom Reinforcement Along Column-B

AstReq (BM)	=	0.2 x (D/2) x 1000/100	
	=	0.2 x 300 x 1000/100	
	=	600	sqmm/m
AstPrv	=	T10 @ 130 C/C	
	=	604	sqmm/m

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Top Reinforcement Along Column-B

D	=	600	mm
	<=	1000	mm, Hence
AstReq (BM)	=	Min Pt for Top Reinforcement X D X 1000	
	=	0.06% X 600 X 1000	
	=	360	sqmm/m
AstPrv	=	T10 @ 215 C/C	
	=	365	sqmm/m

Design for One Way Shear:

Along Column-D

Critical Analysis Load Combination	:	7	
Critical Load Combination	:	[25] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 1: EQX)	
Pcomb	=	858	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	906.6	kN
Mx	=	-97.85	kNm
My	=	-6.92	kNm
Ppile	=	Max Load on pile	
	=	518.5288	kN

Location of critical section is at d/2 from face of column

Section Location from column center	=	570	mm

Data for Piles

Pile No	Load (kN)	% covered	Shear (kN)
P1	518.53	20	414.82
P2	388.07	20	310.45

Design Shear Force (Vu)	=	Max. of (Shear due to P1, P2)	
	=	414.82	kN
Deff	=	540	mm
Beff	=	900	mm
Tv	=	Vu/(Beff x Deff)	
	=	0.85	N/sqmm
Tc	=	0.34	N/sqmm
Av	=	180	Mm

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Shear enhancement factor	=	2 X Deff / Av	
	=	6	
Enhanced shear strength (Tce)	=	2.04	N/sqmm
Tv	<	Tce, Hence Shear Reinforcement is not required	

Along Column-B

One way shear check do not applicable for 2 pile pile-cap design

Design of Face Reinforcement:

AsfrReq	=	SFR % X D X Beffsfr	
	=	0.05 X 600 X 500 / 100	
	=	150	sqmm
Asfr Prv	=	2-T10	
	=	157	sqmm

Check for Load Transfer from Column to PileCap

Critical Analysis Load Combination	=	7	
Critical Load Combination	:	[25] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 1: EQX)	
P	=	858	kN
A2	=	0.18	sqm
A1	=	2.16	sqm
Base Area	=	2.16	sqm
A1	<	Base Area	
Modification Factor	=	SquareRoot(A1/A2) < = 2	
SquareRoot(A1/A2)	=	3.46	
Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 X Fck X Modication Factor X Column Area	
	=	4050	kN
Concrete Bearing Capacity	>	P, Hence Safe.	

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COLUMN DESIGN CALCULATIONS

Project Name	:	PROPOSED RESIDENTIAL BUILDING AT CHENNAI
Client Name	:	GMS
Engineer Name	:	NSS
Design File	:	D:\D DRIVE\GMS\RECEIVED\COLUMN -15-10-2025-1.rcdx
Analysis File	:	D:\D DRIVE\GMS\RECEIVED\GMS -ANNA NAGAR-24.09.2025 rev -15-10-2025.STD
Analysis Last Modified	:	15-10-2025 13:27:44

Definitions Of Terms:

All forces in units kN and m

All reinforcement details like area, spacing are mm

Grade Of steel for 6 mm dia. bars is Fe250. It is irrespective of the grade of steel defined by user in column design.

Neutral axis angle for resultant design moment is with respect to local major axis.

1	β	=	Stiffness proportion factor at joint (column stiffness/sum of stiffness of all members connected at joint)
2	Δu	=	Elastically computed first order lateral deflection.(Relative deflections)
3	ε1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
4	εm	=	Average steel strain at level considered
5	acr	=	Distance from the point considered to the surface of the nearest longitudinal bar
6	Ag	=	Gross area of the column cross section
7	Ak	=	Area of confined concrete core
8	Ash	=	Area of link cross section
9	b	=	Effective Width of Column in mm
10	B	=	Width / Smaller Dimension of Column in mm
11	d	=	Effective Depth of Column in mm
12	D	=	Depth / Larger Dimension of Column OR Diameter of Circular Column in mm
13	Dk	=	Diameter Of core measured to the outside of circular link
14	Ec	=	Modulus of elasticity of concrete
15	Es	=	Modulus of elasticity of steel
16	FcPerm	=	Permissible Stress in Concrete required in N/(sqmm)

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17	Fst	=	Stress in steel
18	FstPerm	=	Permissible Stress in Steel required in N/ (sqmm)
19	Fck	=	Characteristic compressive strength of concrete cube in N/sqmm
20	Fy	=	Yield Stress Of Steel in N/sqmm
21	h	=	Longer dimension of rectangular link measured to its outer face
22	Hu	=	Total lateral force acting within the story(Story shear)
23	Hs	=	Height of the story (Floor height)
24	k	=	Reduction factor for slenderness moments
25	Max	=	Additional moment due to slenderness about major axis (Along D)
26	May	=	Additional moment due to slenderness about minor axis (Along B)
27	Mminx	=	Moment due to minimum eccentricity along D
28	Mminy	=	Moment due to minimum eccentricity along B
29	Muv	=	Moment capacity of web portion of wall as per clause 9.4.2 and Annes A of IS 13920 - 1993
30	Mux	=	Factored moment Along D
31	Muy	=	Factored moment Along B
32	MCap	=	Moment capacity of section for NA angle at design Pu
33	MRes	=	Resultant design moment at angle to local major axis
34	Pb	=	Axial capacity of column as defined in 39.7.1.1
35	Pu	=	Factored axial force
36	Pu_Total	=	Sum of Axial loads on all column in the story (Gravity Load)
37	Q	=	Stability Index (factor for checking sway/ non sway condition for a given story)
38	S	=	Link Spacing
39	Shear Strength Enhancement Factor	=	Multiplying factor for shear strength of concrete as per 40.2.2
40	Vur	=	Factored resultant shear force acting on the column
41	Vux	=	Factored shear force Along D
42	Vuy	=	Factored shear force Along B
43	Wcr	=	Surface Crack Width
44	WcrPerm	=	Permissible Crack Width required in mm
45	β	=	It is a Neutral Axis angle corresponding to load angle to find out MCap

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Code References:

IS 456

	ELEMENT		CLAUSE / table
1	Max area of reinforcement	:	26.5.3.1-a & b
2	Min area of reinforcement	:	26.5.3.1-a & b
3	Min number of bars	:	26.5.3.1-c
4	Minimum Eccentricity Calc	:	25.4 & 39.2
5	Effective Length	:	25.2
6	Slenderness Moments	:	25.3 & 39.7
7	Design for axial loads	:	39.3
8	Design for axial loads And uniaxial bending	:	39.5
9	Design for axial loads And Biaxial bending	:	39.6
10	Design of horizontal links	:	26.5.3.2
11	Design shear strength	:	40.2
12	Stiffness Proportion Factor, β	:	E-1
13	Stability(Index, Q)	:	E -2
14	Crack width calculation	:	3.8
15	Multiplying factor to Beam Stiffness for effective length calculation	:	SP 24 1983 APPENDIX D

IS 13920 - 1993

	ELEMENT		CLAUSE / table
1	Spacing of special confining reinforcement	:	9.4.5 and 7.4
2	C/s area of special confining reinforcement	:	7.4.7
3	Applicability of boundary element	:	9.4.1
4	Muv-Moment Capacity of Web	:	Annex
5	Additional Compressive Force in BE	:	9.4.2
6	Check for BE in tension and compression	:	9.4.3 and 9.4.4
7	Shear include due to Beam	:	7.3.4

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Sway Calculation (Stability Index)

For Global-X Direction

Level	Load Name	Story Height (m)	Gravity Load P (kN)	Relative Displacements (mm)	Story Shear (kN)	Stability Index	Sway Condition
		A	B	C	D	B x C / (A x D)	
0m to 1.5m	LOAD 1: EQX	1.5	23401.962	0.591	821.84	0.011	Non Sway
1.5m to 3.12m	LOAD 1: EQX	1.62	2263.299	1.71	69.383	0.034	Non Sway
3.12m to 4.6m	LOAD 1: EQX	1.48	21804.48	1.704	817.614	0.031	Non Sway
4.6m to 6.22m	LOAD 1: EQX	1.62	1974.659	2.363	54.709	0.053	Sway
6.22m to 7.7m	LOAD 1: EQX	1.48	18207.498	1.326	706.013	0.023	Non Sway
7.7m to 9.32m	LOAD 1: EQX	1.62	1655.441	2.732	45.383	0.062	Sway
9.32m to 10.8m	LOAD 1: EQX	1.48	14885.043	0.684	585.095	0.012	Non Sway
10.8m to 12.42m	LOAD 1: EQX	1.62	1328.577	2.701	31.154	0.071	Sway
12.42m to 13.9m	LOAD 1: EQX	1.48	11562.589	0.136	419.452	0.003	Non Sway
13.9m to 15.52m	LOAD 1: EQX	1.62	995.166	2.279	0.231	6.057	Sway
15.52m to 17m	LOAD 1: EQX	1.48	8240.134	0.699	136.202	0.029	Non Sway
17m to 18.62m	LOAD 1: EQX	1.62	658.659	1.747	7.452	0.095	Sway
20.1m to 22.84m	LOAD 1: EQX	2.74	275.146	1.868	0.721	0.26	Sway
22.84m to 23.1m	LOAD 1: EQX	0.26	1181.245	0.773	0	16293562.006	Sway

For Global-Y Direction

Level	Load Name	Story Height (m)	Gravity Load P (kN)	Relative Displacements (mm)	Story Shear (kN)	Stability Index	Sway Condition
		A	B	C	D	B x C / (A x D)	
0m to 1.5m	LOAD 2: EQZ	1.5	23401.962	1.304	1068.392	0.019	Non Sway
1.5m to 3.12m	LOAD 2: EQZ	1.62	2263.299	3.93	197.593	0.028	Non Sway

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3.12m to 4.6m	LOAD 2: EQZ	1.48	21804.48	3.16	1062.898	0.044	Sway
4.6m to 6.22m	LOAD 2: EQZ	1.62	1974.659	4.727	185.7	0.031	Non Sway
6.22m to 7.7m	LOAD 2: EQZ	1.48	18207.498	2.632	917.817	0.035	Non Sway
7.7m to 9.32m	LOAD 2: EQZ	1.62	1655.441	5.05	143.576	0.036	Non Sway
9.32m to 10.8m	LOAD 2: EQZ	1.48	14885.043	1.293	760.623	0.017	Non Sway
10.8m to 12.42m	LOAD 2: EQZ	1.62	1328.577	5.005	84.769	0.048	Sway
12.42m to 13.9m	LOAD 2: EQZ	1.48	11562.589	0.263	545.287	0.004	Non Sway
13.9m to 15.52m	LOAD 2: EQZ	1.62	995.166	4.476	16.122	0.171	Sway
15.52m to 17m	LOAD 2: EQZ	1.48	8240.134	2.267	177.062	0.071	Sway
17m to 18.62m	LOAD 2: EQZ	1.62	658.659	4.603	24.438	0.077	Sway
18.62m to 20.1m	LOAD 2: EQZ	1.48	4732.605	2.807	0	9846901.015	Sway
20.1m to 22.84m	LOAD 2: EQZ	2.74	275.146	4.012	0.285	1.415	Sway
22.84m to 23.1m	LOAD 2: EQZ	0.26	1181.245	6.092	11.857	2.334	Sway

General Data

Column No.	:	C1	
Level	:	0m To 1.5m	
Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	300	mm
Column D	=	600	mm
Live Load Reduction	=	40	%
Clear Floor Height @ B	=	1050	mm
Clear Floor Height @ D	=	1050	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

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Load Data

Analysis Reference No.	=	2	
Critical Analysis Load Combination	:	9	
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Critical Location	=	Bottom Joint	
Pu	=	744.47	kN
Mux	=	-8.46	kNm
Muy	=	-63.18	kNm
Vux	=	49.04	kN
Vuy	=	-11.97	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	360	No Beam	No Beam	-	-	1
Top	360	3250 x 200 x 450	No Beam	46.731	-	0.939

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	1.2

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	90	No Beam	No Beam	-	-	1
Top	90	5329 x 200 x 450	No Beam	28.5	-	0.864

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Sway Condition (as per Stability Index)	=	Non Sway	
Effective Length Factor along Minor axis	=	1.2	

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	22.1	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	16.45	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	3.5	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / D
	=	2.1, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / B
	=	4.2, Column not Slender Along B

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	MsIndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	-8.46	16.45	-16.45	0	-16.45
Minor Axis - Muy	-63.18	---	-63.18	0	-63.18

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

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E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	744.47	kN
Mux	=	-16.45	kNm
Muy	=	-63.18	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.95	
Reinforcement Provided	=	4-T16 + 8-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	75.4	deg
MRes	=	65.29	kNm
MCap	=	118.19	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.55 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	10	
Critical Load Combination	=	[6] : 0.9 (LOAD 3: DEAD LOAD) +1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	34.4777	kN
Pu	=	117.37	
Deff	=	544	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.2113	N/sqmm
Pt	=	0.475	%
Design shear strength, Tc	=	0.4786	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0782	
Shear Strength Enhancement Factor (max)	=	1.5	
	=	1.0782	

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Shear Strength Enhancement Factor			
Enhanced shear strength, Tc-e	=	0.516	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	
Link for Shear Design along D are not required			

Design for shear along B

Critical Analysis Load Combination	:	13·	
Critical Load Combination	=	[9] : 0.9 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Design shear force, Vux	=	42.9588	kN
Pu	=	499.97	
Beff	=	244	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.2934	N/sqmm
Pt	=	0.475	%
Design shear strength, Tc	=	0.4786	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.3333	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.3333	
Enhanced shear strength, Tc-e	=	0.6381	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	
Link for Shear Design along B are not required			

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 4	mm
Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 300	mm
Max. 300 mm	= 300	mm

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Least lateral edge dimension/2	= 150	
Provided spacing	= 150	mm

Special confining reinforcement as per IS 13920 - 1993

Min. Lateral dimension of column,B	= 300	mm
B/4	= 75	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 158	mm
Gross area of column, Ag	= B x D	
	= 180000	sqmm
Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 117376	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 56.9	sqmm
Diameter of special confining link	= 10	mm
	= > Max. longitudinal bar dia / 4	
	= 4	mm
Zone for special confining links - criterion		
Max. Size of column,D	= 600	mm
Clear height/6	= 175	mm
Minimum value	= 450	mm
Since length of Confining	> Clear height/2	
Length of confining zone	= Clear height/2	
	= 525	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	10	8	10
Spacing	150	---	75	150	75

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General Data

Column No.	:	C1	
Level	:	3.12m To 4.6m	
Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	300	mm
Column D	=	600	mm
Live Load Reduction	=	40	%
Clear Floor Height @ B	=	2650	mm
Clear Floor Height @ D	=	2650	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

Load Data

Analysis Reference No.	=	87	
Critical Analysis Load Combination	:	9	
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Critical Location	=	Top Joint	
Pu	=	617.29	kN
Mux	=	14.57	kNm
Muy	=	83.62	kNm
Vux	=	52.83	kN
Vuy	=	-7.72	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	364.865	No Beam	No Beam	-	-	0.939
Top	364.865	3250 x 200 x 450	No Beam	46.731	-	0.929

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Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	1.2

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	91.216	No Beam	No Beam	-	-	0.864
Top	91.216	5329 x 200 x 450	No Beam	28.5	-	0.806

Sway Condition (as per Stability Index)	=	Sway	
Effective Length Factor along Minor axis	=	1.2	

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	25.3	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	15.62	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	8.83	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / D	
	=	5.3, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

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Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / B
	=	10.6, Column not Slender Along B

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	MsIndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	14.57	15.62	15.62	0	15.62
Minor Axis - Muy	83.62	---	83.62	0	83.62

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	617.29	kN
Mux	=	15.62	kNm
Muy	=	83.62	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.95	
Reinforcement Provided	=	4-T16 + 8-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	79.42	deg
MRes	=	85.07	kNm
MCap	=	115.88	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.73 <= 1	

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Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	10	
Critical Load Combination	=	[6] : 0.9 (LOAD 3: DEAD LOAD) +1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	38.8	kN
Pu	=	90.45	
Deff	=	544	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.2377	N/sqmm
Pt	=	0.475	%
Design shear strength, Tc	=	0.4786	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0603	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0603	
Enhanced shear strength, Tc-e	=	0.5074	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	13	
Critical Load Combination	=	[9] : 0.9 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Design shear force, Vux	=	45.9388	kN
Pu	=	419.48	
Beff	=	244	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.3138	N/sqmm
Pt	=	0.475	%
Design shear strength, Tc	=	0.4786	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2797	

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Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2797	
Enhanced shear strength, Tc-e	=	0.6124	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	
Link for Shear Design along B are not required			

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 4	mm
Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 300	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 150	
Provided spacing	= 150	mm

Special confining reinforcement as per IS 13920 - 1993

Min. Lateral dimension of column,B	= 300	mm
B/4	= 75	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 158	mm
Gross area of column, Ag	= B x D	
	= 180000	sqmm
Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 117376	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 56.9	sqmm
Diameter of special confining link	= 10	mm
	= > Max. longitudinal bar dia / 4	
	= 4	mm
Zone for special confining links - criterion		

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Max. Size of column,D	= 600	mm
Clear height/6	= 441.67	mm
Minimum value	= 450	mm
Hence length of confining zone	= 600	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	10	8	10
Spacing	150	---	75	150	75

General Data

Column No.	:	C1	
Level	:	6.22m To 7.7m	
Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	200	mm
Column D	=	600	mm
Live Load Reduction	=	40	%
Clear Floor Height @ B	=	2650	mm
Clear Floor Height @ D	=	2650	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

Load Data

Analysis Reference No.	=	228	
Critical Analysis Load Combination	:	9	
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Critical Location	=	Top Joint	
Pu	=	487.57	kN
Mux	=	8.24	kNm
Muy	=	41.69	kNm

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Vux	=	24.59	kN
Vuy	=	-3.08	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	243.243	No Beam	No Beam	-	-	0.929
Top	243.243	3250 x 200 x 450	No Beam	46.731	-	0.912

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	1.2

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	27.027	No Beam	No Beam	-	-	0.806
Top	27.027	5329 x 200 x 450	No Beam	28.5	-	0.655

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Minor axis	=	1.2

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	11.97	mm

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Mminy	=	Pu x Minimum Eccentricity	
	=	9.75	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	13.25	
	<	60	(Hence Ok)
Column Is Unbraced Along D			
Slenderness Check Along D:			
Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / D	
	=	5.3, Column not Slender Along D	
Column Is Unbraced Along B			
Slenderness Check Along B:			
Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / B	
	=	15.9, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	12.33	kNm

Reduction factor 'k' for slenderness moment			
Puz	=	2017.36	kN
Pb	=	396.65	kN
k	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	1.1877 > = 1	
Design slenderness moment along B	=	k x 12.33	
MsIndy	=	11.63	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	MsIndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	8.24	---	8.24	0	8.24
Minor Axis - Muy	41.69	9.75	41.69	11.63	53.33

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

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F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	487.57	kN
Mux	=	8.24	kNm
Muy	=	53.33	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	1.53	
Reinforcement Provided	=	8-T16 + 2-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	81.22	deg
MRes	=	53.96	kNm
MCap	=	55.08	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.98 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	10	
Critical Load Combination	=	[6] : 0.9 (LOAD 3: DEAD LOAD) +1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	36.0885	kN
Pu	=	89.51	
Deff	=	544	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.3317	N/sqmm
Pt	=	0.764	%
Design shear strength, Tc	=	0.5791	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0895	
Shear Strength Enhancement Factor (max)	=	1.5	

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Shear Strength Enhancement Factor	=	1.0895	
Enhanced shear strength, Tc-e	=	0.6309	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	13	
Critical Load Combination	=	[9] : 0.9 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Design shear force, Vux	=	20.0259	kN
Pu	=	327.07	
Beff	=	144	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.2318	N/sqmm
Pt	=	0.764	%
Design shear strength, Tc	=	0.5791	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.3271	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.3271	
Enhanced shear strength, Tc-e	=	0.7684	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	

Link for Shear Design along B are not required

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 4	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 200	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 100	

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Provided spacing	= 100	mm

Special confining reinforcement as per IS 13920 - 1993

Min. Lateral dimension of column,B	= 200	mm
B/4	= 50	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 162	mm
Gross area of column, Ag	= B x D	
	= 120000	sqmm
Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 67584	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 84.81	sqmm
Diameter of special confining link	= 12	mm
	= > Max. longitudinal bar dia / 4	
	= 4	mm
Zone for special confining links - criterion		
Max. Size of column,D	= 600	mm
Clear height/6	= 441.67	mm
Minimum value	= 450	mm
Hence length of confining zone	= 600	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	12	8	12
Spacing	100	---	75	100	75

General Data

Column No.	:	C1	
Level	:	9.32m To 10.8m	
Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm

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Column B	=	200	mm
Column D	=	600	mm
Live Load Reduction	=	30	%
Clear Floor Height @ B	=	2650	mm
Clear Floor Height @ D	=	2650	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

Load Data

Analysis Reference No.	=	252	
Critical Analysis Load Combination	:	9	
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Critical Location	=	Top Joint	
Pu	=	370.66	kN
Mux	=	5.94	kNm
Muy	=	43.32	kNm
Vux	=	27.76	kN
Vuy	=	-2.44	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	243.243	No Beam	No Beam	-	-	0.912
Top	243.243	3250 x 200 x 450	No Beam	46.731	-	0.912

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	1.2

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Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	27.027	No Beam	No Beam	-	-	0.655
Top	27.027	5329 x 200 x 450	No Beam	28.5	-	0.655

Sway Condition (as per Stability Index) = Non Sway

Effective Length Factor along Minor axis = 1.2

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity = Unsupported Length / 500 + B / 30

= 11.97 mm

Mminy = Pu x Minimum Eccentricity

= 7.41 kNm

Slenderness Check

Max Slenderness Ratio(L/B) = 13.25

< 60 (Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor = 1.2

Slenderness Ratio = Effective Length / D

= 5.3, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor = 1.2

Slenderness Ratio = Effective Length / B

= 15.9, Column Slender Along B

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Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	9.37	kNm

Reduction factor 'k' for slenderness moment

Puz	=	2017.36	kN
Pb	=	396.65	kN
k	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	1.2785 > = 1	
Design slenderness moment along B	=	k x 9.37	
Mslndy	=	9.37	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	5.94	---	5.94	0	5.94
Minor Axis - Muy	43.32	7.41	43.32	9.37	52.69

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	370.66	kN
Mux	=	5.94	kNm
Muy	=	52.69	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	1.53	
Reinforcement Provided	=	8-T16 + 2-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	83.57	deg

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MRes	=	53.02	kNm
MCap	=	53.1	kNm
Capacity Ratio	=	MRes/ MCap	
	=	1 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	10	
Critical Load Combination	=	[6] : 0.9 (LOAD 3: DEAD LOAD) +1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	31.4973	kN
Pu	=	94.33	
Deff	=	544	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.2895	N/sqmm
Pt	=	0.764	%
Design shear strength, Tc	=	0.5791	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0943	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0943	
Enhanced shear strength, Tc-e	=	0.6337	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	13	
Critical Load Combination	=	[9] : 0.9 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Design shear force, Vux	=	22.377	kN
Pu	=	244.9	
Beff	=	144	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.259	N/sqmm
Pt	=	0.764	%

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Design shear strength, Tc	=	0.5791	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2449	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2449	
Enhanced shear strength, Tc-e	=	0.7209	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	

Link for Shear Design along B are not required

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 4	mm
Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 200	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 100	
Provided spacing	= 100	mm

Special confining reinforcement as per IS 13920 - 1993

Min. Lateral dimension of column,B	= 200	mm
B/4	= 50	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 162	mm
Gross area of column, Ag	= B x D	
	= 120000	sqmm
Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 67584	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 84.81	sqmm

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Diameter of special confining link	= 12	mm
	= > Max. longitudinal bar dia / 4	
	= 4	mm
Zone for special confining links - criterion		
Max. Size of column,D	= 600	mm
Clear height/6	= 441.67	mm
Minimum value	= 450	mm
Hence length of confining zone	= 600	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	12	8	12
Spacing	100	---	75	100	75

General Data

Column No.	:	C1	
Level	:	12.42m To 13.9m	
Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	200	mm
Column D	=	600	mm
Live Load Reduction	=	20	%
Clear Floor Height @ B	=	2650	mm
Clear Floor Height @ D	=	2650	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

Load Data

Analysis Reference No.	=	276
Critical Analysis Load Combination	:	9
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)

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Critical Location	=	Top Joint	
Pu	=	258.9	kN
Mux	=	4.28	kNm
Muy	=	38.35	kNm
Vux	=	24.11	kN
Vuy	=	-1.34	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	243.243	No Beam	No Beam	-	-	0.912
Top	243.243	3250 x 200 x 450	No Beam	46.731	-	0.912

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	1.2

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	27.027	No Beam	No Beam	-	-	0.655
Top	27.027	5329 x 200 x 450	No Beam	28.5	-	0.655

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Minor axis	=	1.2

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

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Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	11.97	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	5.18	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	13.25	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / D	
	=	5.3, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / B	
	=	15.9, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	6.55	kNm

Reduction factor 'k' for slenderness moment

Puz	=	1889.38	kN
Pb	=	418	kN
k	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	1.3691 > = 1	
Design slenderness moment along B	=	k x 6.55	
Mslndy	=	6.55	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	4.28	---	4.28	0	4.28
Minor Axis - Muy	38.35	5.18	38.35	6.55	44.9

Where

A = Moments directly from analysis

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B	=	Moments due to minimum eccentricity
C	=	Maximum of analysis moment and min. eccentricity = Max (A,B)
E	=	Moment due to slenderness effect
F	=	Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	258.9	kN
Mux	=	4.28	kNm
Muy	=	44.9	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	1.24	
Reinforcement Provided	=	4-T16 + 6-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	84.56	deg
MRes	=	45.1	kNm
MCap	=	47.53	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.95 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	10	
Critical Load Combination	=	[6] : 0.9 (LOAD 3: DEAD LOAD) +1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	22.8671	kN
Pu	=	89.1	
Deff	=	544	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.2102	N/sqmm
Pt	=	0.618	%
Design shear strength, Tc	=	0.5325	N/sqmm

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Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0891	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0891	
Enhanced shear strength, Tc-e	=	0.58	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	9	
Critical Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Design shear force, Vux	=	24.1105	kN
Pu	=	258.9	
Beff	=	144	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.2791	N/sqmm
Pt	=	0.618	%
Design shear strength, Tc	=	0.5325	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2589	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2589	
Enhanced shear strength, Tc-e	=	0.6704	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	

Link for Shear Design along B are not required

<u>Design Of Links</u>

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 4	mm

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Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 200	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 100	
Provided spacing	= 100	mm

Special confining reinforcement as per IS 13920 - 1993

Min. Lateral dimension of column,B	= 200	mm
B/4	= 50	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 162	mm
Gross area of column, Ag	= B x D	
	= 120000	sqmm
Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 67584	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 84.81	sqmm
Diameter of special confining link	= 12	mm
	= > Max. longitudinal bar dia / 4	
	= 4	mm
Zone for special confining links - criterion		
Max. Size of column,D	= 600	mm
Clear height/6	= 441.67	mm
Minimum value	= 450	mm
Hence length of confining zone	= 600	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	12	8	12
Spacing	100	---	75	100	75

General Data

Column No. : C1

Level : 15.52m To 17m

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Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	200	mm
Column D	=	600	mm
Live Load Reduction	=	10	%
Clear Floor Height @ B	=	2650	mm
Clear Floor Height @ D	=	2650	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

Load Data

Analysis Reference No.	=	300	
Critical Analysis Load Combination	:	9	
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Critical Location	=	Top Joint	
Pu	=	155.03	kN
Mux	=	5.2	kNm
Muy	=	30.16	kNm
Vux	=	18.93	kN
Vuy	=	-0.88	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	243.243	No Beam	No Beam	-	-	0.912
Top	243.243	3250 x 200 x 450	No Beam	46.731	-	0.912

Sway Condition (as per Stability Index)	=	Non Sway

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Effective Length Factor along Major Axis	=	1.2

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	27.027	No Beam	No Beam	-	-	0.655
Top	27.027	5329 x 200 x 450	No Beam	28.5	-	0.655

Sway Condition (as per Stability Index)	=	Sway	
Effective Length Factor along Minor axis	=	1.2	

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	25.3	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	3.92	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	13.25	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / D
	=	5.3, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2

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Slenderness Ratio	=	Effective Length / B	
	=	15.9, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	3.92	kNm

Reduction factor 'k' for slenderness moment

Puz	=	1761.4	kN
Pb	=	452.73	kN
k	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	1.5082 > = 1	
Design slenderness moment along B	=	k x 3.92	
Mslndy	=	3.92	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	5.2	3.92	5.2	0	5.2
Minor Axis - Muy	30.16	---	30.16	3.92	34.08

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	155.03	kN
Mux	=	5.2	kNm
Muy	=	34.08	kNm

Resultant Moment (Combined Action)

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Moment Capacity Check

Pt Calculated	=	0.94	
Reinforcement Provided	=	10-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	81.33	deg
MRes	=	34.48	kNm
MCap	=	40.92	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.84 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	10	
Critical Load Combination	=	[6] : 0.9 (LOAD 3: DEAD LOAD) +1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	16.3852	kN
Pu	=	69.62	
Deff	=	546	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.15	N/sqmm
Pt	=	0.471	%
Design shear strength, Tc	=	0.4771	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0696	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0696	
Enhanced shear strength, Tc-e	=	0.5104	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	9	
Critical Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Design shear force, Vux	=	18.9305	kN

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Pu	=	155.03	
Beff	=	146	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.2161	N/sqmm
Pt	=	0.471	%
Design shear strength, Tc	=	0.4771	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.155	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.155	
Enhanced shear strength, Tc-e	=	0.5511	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	

Link for Shear Design along B are not required

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 3	mm
Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 200	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 100	
Provided spacing	= 100	mm

Special confining reinforcement as per IS 13920 - 1993

Min. Lateral dimension of column,B	= 200	mm
B/4	= 50	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 159	mm
Gross area of column, Ag	= B x D	
	= 120000	sqmm

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Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 67584	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 83.24	sqmm
Diameter of special confining link	= 12	mm
	= > Max. longitudinal bar dia / 4	
	= 3	mm
Zone for special confining links - criterion		
Max. Size of column,D	= 600	mm
Clear height/6	= 441.67	mm
Minimum value	= 450	mm
Hence length of confining zone	= 600	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	12	8	12
Spacing	100	---	75	100	75

General Data

Column No.	:	C1	
Level	:	18.62m To 20.1m	
Design Code	=	IS 456 + IS 13920 - 1993	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	200	mm
Column D	=	600	mm
Live Load Reduction	=	0	%
Clear Floor Height @ B	=	2650	mm
Clear Floor Height @ D	=	2650	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	

Load Data

Analysis Reference No. = 324

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Critical Analysis Load Combination	:	9	
Load Combination	=	[5] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 2: EQZ)	
Critical Location	=	Top Joint	
Pu	=	60.45	kN
Mux	=	-7.56	kNm
Muy	=	28.73	kNm
Vux	=	17.81	kN
Vuy	=	5.97	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	243.243	No Beam	No Beam	-	-	0.912
Top	243.243	3250 x 200 x 450	No Beam	46.731	-	0.839

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	1.2

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N/m	mm	mm	N/m	N/m	
Bottom	27.027	No Beam	No Beam	-	-	0.655
Top	27.027	5329 x 200 x 450	No Beam	28.5	-	0.487

Sway Condition (as per Stability Index)	=	Sway
Effective Length Factor along Minor axis	=	1.2

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Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	25.3	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	1.53	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	13.25	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / D	
	=	5.3, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2	
Slenderness Ratio	=	Effective Length / B	
	=	15.9, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	1.53	kNm

Reduction factor 'k' for slenderness moment

Puz	=	1761.4	kN
Pb	=	452.73	kN
k	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	1.597 > = 1	
Design slenderness moment along B	=	k x 1.53	
Mslndy	=	1.53	kNm

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Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Msindx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	-7.56	1.53	-7.56	0	-7.56
Minor Axis - Muy	28.73	---	28.73	1.53	30.26

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	60.45	kN
Mux	=	-7.56	kNm
Muy	=	30.26	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.94	
Reinforcement Provided	=	10-T12	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	75.97	deg
MRes	=	31.19	kNm
MCap	=	41.77	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.75 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	7	
Critical Load Combination	=	[3] : 1.5 (LOAD 3: DEAD LOAD) -1.5 (LOAD 1: EQX)	
Design shear force, Vuy	=	10.6844	kN

S.C

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Pu	=	57.71	
Deff	=	546	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.0978	N/sqmm
Pt	=	0.471	%
Design shear strength, Tc	=	0.4771	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0577	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0577	
Enhanced shear strength, Tc-e	=	0.5047	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	5	
Critical Load Combination	=	[1] : 1.5 (LOAD 3: DEAD LOAD) +1.5 (LOAD 4: LIVE LOAD)	
Design shear force, Vux	=	18.248	kN
Pu	=	67.04	
Beff	=	146	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.2083	N/sqmm
Pt	=	0.471	%
Design shear strength, Tc	=	0.4771	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.067	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.067	
Enhanced shear strength, Tc-e	=	0.5091	N/sqmm
Design shear check	=	Tvx < Tc x Enhancement factor	

Link for Shear Design along B are not required

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Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	= 8	mm
	> Max. longitudinal bar dia / 4	
	= 3	mm
Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 192	mm
Min. dimension of column	= 200	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 100	
Provided spacing	= 100	mm
Special confining reinforcement as per IS 13920 - 1993		
Min. Lateral dimension of column,B	= 200	mm
B/4	= 50	mm
Hence Link spacing, S	= 75	mm
Hoop dimension, h	= 159	mm
Gross area of column, Ag	= B x D	
	= 120000	sqmm
Core area of column, Ak	= (B- 2 x cover to Link) x (D- 2 x cover to Link)	
	= 67584	sqmm
Area of special confining link, Ash	= 0.18 x S x h x (Fck/Fy) x (Ag/Ak-1)	
	= 83.24	sqmm
Diameter of special confining link	= 12	mm
	= > Max. longitudinal bar dia / 4	
	= 3	mm
Zone for special confining links - criterion		
Max. Size of column,D	= 600	mm
Clear height/6	= 441.67	mm
Minimum value	= 450	mm
Hence length of confining zone	= 600	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	12	8	12
Spacing	100	---	75	100	75

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BEAM DESIGN CALCULATION

Project Name	:	PROPOSED RESIDENTIAL BUILDING AT CHENNAI
Client Name	:	GMS
Engineer Name	:	NSS
Design File	:	D:\D DRIVE\GMS\RECEIVED\PLINTH BEAM -15-10-2025.rcdx
Analysis File	:	D:\D DRIVE\GMS\RECEIVED\GMS -ANNA NAGAR-24.09.2025 rev -15-10-2025.STD
Analysis Last Modified	:	15-10-2025 12:42:11
Level Designed	:	1.5m

Sr.No.	Symbol		Definitions
1	α	=	Angle formed with horizontal by diagonal reinforcement
2	ε1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
3	εm	=	Average steel strain at level considered
4	Acr	=	Distance from the point considered to the surface of the nearest longitudinal bar
5	Adr	=	Area of diagonal reinforcement in coupler beam
6	AstCalc	=	Area of Tension reinforcement required in sqmm
7	Ast comp	=	Ast at compression side
8	AstCrack	=	Area of Tension reinforcement for Crack Width required in sqmm
9	AstPrv	=	Area of reinforcement provided at given section in sqmm
10	Asv	=	Area of shear reinforcement required per meter length in sqmm
11	Asv Reqd	=	Min area shear reinforcement as per clause 41.4.3
12	Asv Total Prv	=	Total area of shear reinforcement provided, including that for torsion
13	Asv Torsion	=	Area of Stirrups over the corner bars to resist shear and torsion as per clause 41.4.3
14	Asv Torsion Prv	=	Area of shear reinforcement resisting torsion (outer legs only)
15	b	=	Width of the Beam in mm
16	bw	=	Width of Web in mm
17	Ceff	=	Effective Cover of Beam in mm
18	Cmin	=	Clear cover
19	d	=	Effective depth of Beam in mm

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20	d'	=	Clear cover to reinforcement at compression side.
21	D	=	Depth of Beam in mm
22	D'	=	Distance (c/c) between top-most and bottom-most layer
23	Df	=	Thickness of Flange in mm
24	Ec	=	Modulus of elasticity of concrete
25	Es	=	Modulus of elasticity of steel
26	FcPerm	=	Permissible Stress in Concrete required in N/sqmm
27	Fst	=	Stress in steel
28	FstPerm	=	Permissible Stress in Steel required in N/sqmm
29	Legs	=	Number of legs of the shear reinforcement
30	lo	=	Effective Length of Beam in mm
31	Mh	=	Hogging Moment of Resistance in kNm
32	Ms	=	Sagging Moment of Resistance in kNm
33	M_{Tu}	=	Converted Bending Moment due to Torsion at a section in kNm
34	Mu	=	Factored Bending Moment in Limit State at a section in kNm
35	Mud	=	Total Design Moment = Mu + M_{Tu} in kNm
36	MuLim	=	Limiting Moment of Resistence of Singly Reinforced Section
37	NA angle (φ)	=	It is a neutral axis angle corresponding to load angle to find out MCap
38	Pcclc	=	Calculated percentage compression steel
39	Ptclc	=	Calculated percentage tension steel
40	Ptmin	=	Minimum percentage steel as per code
41	PtPrv	=	provided percentage steel
42	R	=	Moment Ratio Mud/Bd^2
43	Reinf	=	Rebar arrangement provided
44	sp	=	Spacing Between bars at outer most layer
45	Spc1 to Spc6	=	Max Stirrup Criteria in mm
46	Stirrup Dia	=	Diameter of shear stirrups in mm
47	SvCalc	=	Stirrup spacing calculated as per Asv in mm
48	SvPrv	=	Stirrup spacing provided in m
49	Tc	=	Permissible Shear stress in concrete at a given section in N/sqmm Calculated as per Tensile reinforcement
50	Tce	=	Earthquake inducted shear stress in N/sqmm
51	Tcep	=	Permissible value of shear stress for checking of coupling action in N/sqmm

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52	Tu	=	Factored Torsional Moment in Limit State at a section in kNm
53	Tv	=	Shear stress due to Vud in N/sqmm
54	V^{D+L}	=	Shear force 1.2x(Dead Load + Live Load) in kN
55	Vc	=	Shear capacity of concrete section due to Tc in kN
56	Vu	=	Factored Shear Force in Limit State at a section in kN
57	Vu-A1	=	V^{D+L}Left - 1.4 x (MsLeft + MhRight)/L in kN
58	Vu-A2	=	V^{D+L}Left + 1.4 x (MhLeft + MsRight)/L in kN
59	Vu-B1	=	V^{D+L}Right + 1.4 x (MsLeft + MhRight)/L in kN
60	Vu-B2	=	V^{D+L}Right - 1.4 x (MhLeft + MsRight)/L in kN
61	Vud	=	Design Shear Force (Max of Vus and Vu-sway) in kN
62	Vue	=	Earthquake inducted shear in kN
63	Vu-sway	=	Max of (Vu-A1 and Vu-A2) & (Vu-B1 and Vu-B2) in kN
64	Vus	=	Vud - Vc Design Shear Force for reinforcement, in kN
65	Vut	=	Total Shear Force = Vu + V_{Tu} in kN
66	V_{Tu}	=	Converted Shear Force due to Torsion at a section in kN
67	Wcr	=	Surface Crack Width
68	WcrPerm	=	Permissible Crack Width required in mm
69	X1	=	Smaller c/c dimension of outermost Stirrups
70	Y1	=	Larger c/c dimension of outermost Stirrups
			All 6mm diameter bars are assumed 250 grade with fy = 250 N/sqmm

All Forces are In kN, kNm, Stress In N/sqmm & Dimension are In mm.

Code References

IS 456

Sr.No.	Item	Clause / Table
1.	Ptmax	: 26.5.1.1
2.	Ptmin	: 26.5.1.1
3.	M_{Tu}	: 41.4.2
4.	V_{Tu}	: 41.3.1
5.	Ptclc	: 38
6.	Tc	: 40.2.1
7.	Tcmax	: 40.2.3

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8.	Asv	: 40.4
9.	Min Shear Reinf	: 26.5.1.6
10.	Max Stirrup Spacing	: 26.5.1.5
11.	Shear Reinf - Torsion	: 26.5.1.7
12.	Side Face Reinforcement	: 26.5.1.3
13.	crack width calculation	: Annex-F
14.	cracking	: Clause 35.3.2

IS 13920 - 1993

Sr.No.	Item	Clause / Table
1.	Ptmax	: 6.2.2
2.	Ptmin	: 6.2.1
3.	Astmin	: 6.2.3 & 6.2.4
4.	Svclc	: 6.3.5

Group		: G8	
Beam No		: B23	
Analysis Reference (Member)	1.5m	: 62	
Beam Length		: 2032	mm
Breadth (B)		: 200	mm
Depth (D)		: 450	mm
Effective Depth (d)		: 395	mm
Design Code		: IS 456	
Beam Type		: Regular Beam	
Grade Of Concrete (Fck)		: M25	N/sqmm
Grade Of Steel		: Fe500	N/sqmm
Clear Cover (Cmin)		: 25	mm
Es		: 2x10^5	N/sqmm

Flexure Design

	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - Analysis	13	8	12	8	9	9
Critical L/C - RCDC	9	4	8	4	5	5
Mu (kNm)	110.939	68.824	125.81	113.901	69.523	135.872
Tu (kNm)	0	1.396	1.06	1.396	0.286	0.286

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M_{Tu} (kNm)	0	2.67	2.03	2.67	0.55	0.55
Mud (kNm)	110.94	71.49	127.83	116.57	70.07	136.42
MuLim (kNm)	104	104	104	104	104	104
R	3.555	2.291	4.097	3.736	2.245	4.372
Ptmin (%)	0.25	0.25	0.25	0.25	0.25	0.25
Ptclc (%)	1.005	0.599	1.149	1.053	0.585	1.223
Pcclc (%)	0.069	0	0.231	0.123	0	0.314
PtPrv (%)	1.082	0.795	1.304	1.082	0.795	1.304
AstCalc (sqmm)	793.72	473	907.94	831.79	462.13	966
AstPrv (sqmm)	854.52	628.32	1030.44	854.52	628.32	1030.44
Reinforcement	2-T20 2-T12	2-T20	2-T20 2-T16	2-T20 2-T12	2-T20	2-T20 2-T16

Shear Design			
	Left	**Mid**	**Right**
Critical L/C - Analysis	8	8	9
Critical L/C - RCDC	4	4	5
PtPrv (%)	1.082	0.795	0.795
Vu (kN)	129.444	120.987	125.359
Tu (kNm)	1.396	1.396	0.286
V_{Tu} (kN)	11.17	11.17	2.29
Vut (kN)	140.61	132.15	127.64
Tv (N/sqmm)	1.78	1.67	1.62
Tc (N/sqmm)	0.66	0.59	0.59
Vc (kN)	52.17	46.45	46.45
Vus=Vut-Vc (kN)	88.44	85.7	81.19
Legs	2	2	2
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	455.657	431.001	381.502
Asv Torsion Prv (sqmm)	718.14	718.14	718.14
Asv Reqd (sqmm)	620.162	600.937	569.314
SvCalc (mm)	140	140	140
SvPrv (mm)	140	140	140
Asv Total Prv (sqmm)	718.14	718.14	718.14

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Maximum Spacing Criteria

Basic

Spc1 =0.75d	= 296	mm
Spc2	= 300	mm

For Torsion

(X1 = 160, Y1 = 410)

Spc3 = X1	= 160	mm
Spc4=(X1+Y1)/4	= 140	mm

SFR Design

Beam Width	= 200	mm
Beam Depth	= 450	mm
Web Depth	= 450 <= 750	mm

Side Face Reinforcement Not Required.

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SLAB DESIGN CALCULATIONS

Project Name	:	PROPOSED REESIDENTIAL BUILDING AT CHENNAI
Client Name	:	GMS
Engineer Name	:	NSS
Design File	:	D:\D DRIVE\GMS\RECEIVED\SLAB CALCULATION.
Analysis File	:	D:\D DRIVE\GMS\RECEIVED\GMS -ANNA NAGAR-24.09.2025 rev -15-10-2025.STD

NOTES:

1. Slab is designed as per 1 M width of panel.
2. Density of concrete assumed as 25 kN/Cum.
3. Maximum spacing of Main steel is smaller of (3 x Deff and 300 mm)
4. Maximum spacing of Distribution steel is smaller of (5 x Deff and 450 mm)
5. All 6 mm diameter bars assumed of Fe250 grade with Fy=250 N/sq.mm

Definitions Of Terms: :

1. α	=	Coefficient of Thermal Expansion
2. acr	=	Distance from the point considered to the surface of the nearest longitudinal bar
3. εm	=	Average steel strain at level considered
4. εl	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
5. ρact	=	Percentage steel provided
6. ρcrit	=	Percentage steel critical as per code
7. BM	=	Bending moment in kNm
8. D	=	Overall depth of slab in mm
9. Deff	=	Effective depth of slab in mm
10. Ec	=	Modulus of elasticity of concrete
11. Es	=	Modulus of elasticity of steel
12. Fck	=	Characteristic compressive strength of concrete cube in N/sqmm
13. Fst	=	Stress in steel
14. Fy	=	Yield Stress Of Steel in N/sqmm
15. Mu	=	Factored Bending moment in kNm
16. Sp	=	Spacing Between bars at outer most layer
17. Tc	=	Permissible Shear stress in concrete in N/sqmm
18. Temp1	=	Peak Hydration temperature
19. Temp2	=	Seasonal Temperature Variations
20. Tv	=	Shear stress due to Vu in N/sqmm
21. V	=	Shear force in kN

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22.	Vu	=	Factored shear force in kN
23.	Wcr	=	Surface Crack Width

Code References :

IS 456

	ELEMENT		CLAUSE / TABLE
1.	Moment Coeffs For 2-Way Slabs	:	Greschoff-Rankine Formulation and yield line theory
2.	Ptmin	:	26.5.2.1
3.	Ptcalculated	:	38
4.	Shear Strength Of Concrete	:	40.3
5.	Modification Factor for Shear	:	40.2.1.1
6.	Max Nominal Shear Stress	:	40.2.3
7.	Basic Span To Depth Ratio	:	23.2.1
8.	Tensile Steel Factor	:	23.2.1
9.	Compression Steel Factor	:	23.2.1
10.	Flange correction factor	:	23.2.1
11.	spacing between main bars	:	26.3.3
12.	spacing between distribution bars	:	26.3.3
13.	crack width calculation	:	Annex-F
14.	cracking	:	Clause 35.3.2

BS 8007 (For Early / Initial Thermal Cracking)

	ELEMENT		CLAUSE / TABLE
1.	Surface Zone for suspended slab	:	Figure A.1
2.	Surface Zone for ground slab	:	Figure A.2
3.	Factors for the calculation of minimum reinforcement	:	Table A.1

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Slab No. :	S1		
Level	=	4.6m	
Design Code	=	IS Code	
Grade Of Concrete	=	M25	
Grade Of Steel	=	Fe500	
Clear Cover	=	25.000	mm
Long Span, Ly	=	5.352	m
Short Span, Lx	=	3.680	m
Imposed Load	=	1.500	kN/sqm
Live Load	=	2.000	kN/sqm
Slab Thickness	=	125.000	mm
Effective Depth Along LX, Deffx	=	95.000	mm
Effective Depth Along LY, Deffy	=	85.000	mm
Self Weight	=	3.125	kN/sqm
Total Load, TL	=	6.625	kN/sqm
Span	=	2-Way	
Panel Type	=	Interior Panel	
Load Combination	=	1.5 DL + 1.5 LL	

Design Moments:

Short Span Positive Moment At Midspan -

Moment Coefficient	=	0.041	
BM	=	3.678	kNm
Mu = 1.5 X BM	=	5.517	kNm
Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 200 C/C	
	=	392.000	sqmm/m

Short Span Negative Moment At Continuous Support -

Moment Coefficient	=	0.053	
BM	=	4.755	kNm
Mu = 1.5 X BM	=	7.132	kNm
Area Of Reinforcement Required (Mu)	=	179.000	sqmm/m
Reinforcement Provided	=	T10 @ 200 C/C	
	=	392.000	sqmm/m

Long Span Positive Moment At Midspan -

Moment Coefficient	=	0.024	
BM	=	2.153	kNm
Mu = 1.5 X BM	=	3.229	kNm

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Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 200 C/C	
	=	392.000	sqmm/m

Long Span Negative Moment At Continuous Support -

Moment Coefficient	=	0.032	
BM	=	2.871	kNm
Mu = 1.5 X BM	=	4.306	kNm
Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 200 C/C	
	=	392.000	sqmm/m

Distribution Reinforcement @ 0.12% -

Area Of Reinforcement Required	=	114.000	sqmm/m
Reinforcement Provided	=	T10 @ 200 C/C	
	=	392.000	sqmm/m

Shear Check :

Along Short Span

Shear Coefficient(Lx), SF1	=	0.441	
V = SF1 x TL x Lx	=	10.752	kN
Vu = 1.5 X V	=	16.128	kN
Shear Stress, Tv	=	0.169	N/sqmm
Nominal Shear Stress, Tc	=	0.318	N/sqmm
Modification Factor 'K'	=	1.300	
K x Tc	=	0.413	
	>	0.169	Slab Is Safe In Shear

Along Long Span

Shear Coefficient(Ly), SF2	=	0.330	
V = SF2 x TL x Lx	=	8.045	kN
Vu = 1.5 X V	=	12.06	kN
Shear Stress, Tv	=	0.142	N/sqmm
Nominal Shear Stress, Tc	=	0.298	N/sqmm
Modification Factor 'K'	=	1.300	
K x Tc	=	0.387	
	>	0.142	Slab Is Safe In Shear

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Deflection Check:

Basic Span To Depth Ratio	=	26	
Span Correction Factor	=	1.000	
Tensile Steel Factor	=	2.925	
Compression Steel Factor	=	1.000	
Flange Correction Factor	=	1.000	
Max Span To Depth Ratio	=	26x 1.00 x 2.925 x 1.00 x 1.00	
	=	76.05	
Lx/d	=	38.73	
	<	76.05	Slab Is Safe In Deflection

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THE LANDLENS SUITE

Eight ways to know a piece of land before you pay for it.

This report covers one part of the picture. These cover the rest, drawn from the same government records, for any property in Tamil Nadu.

LandLens One
Ask anything about a property and get an answer grounded in live government records, with the sources shown.
/landlens/one

Verify My Land
Every record check run on one property and returned as a single report.
/landlens/verify-my-land

Legal Opinion
An advocate's written opinion on the title, built on the records we pull for it.
/landlens

One Map
Every layer on one map: the parcel, its boundary, zoning, water bodies and what sits around it.
/landlens/one/map

PriceMap
What land actually changed hands for around this plot, taken from the registered deeds.
/landlens/pricemap

Build Scope
What you are allowed to build here: floor space, height, coverage and setbacks.
/landlens/build-scope

Property Tracker
Watch a property and hear about it when something new is registered against it.
/landlens/property-tracker

Deal Room
Run the transaction in one place: documents, stamping, signatures and the parties.
/landlens/deal-room

FREE TOOLS · NO ACCOUNT NEEDED

Twenty-four checks you can run yourself, at no cost.

Records and verification

The registers themselves, read for you.

- Encumbrance Certificate
- Patta and Chitta
- Field Measurement Sketch
- EC Analyzer
- Bank charge check
- Court case search
- Seller background check
- Approval check by survey

Value and duty

What it is worth and what it costs to register.

- Guideline value by street
- Guideline value by survey
- Stamp duty and registration fees
- Capital gains
- Floor space index
- Area unit converter

Zoning and land use

What the plan says can happen on this land.

- Land use zone finder
- CMDA land use check
- Coastal regulation zone
- Master plan check
- Water bodies finder
- Airport height clearance

Registers and directories

Who holds it, and which office keeps the record.

- Find your registering office
- Temple property check
- Waqf property check
- RERA register

Every free tool
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The LandLens suite
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- Legal opinions, due diligence and title verification
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