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Structural Design Details

Of

The Proposed Construction of Residential Building (Affordable Housing Project) in Old S.F.No. 205/5A, New S.F.No. 205/13, Plot No. 378 A in Approved Layout L.P (R) /NTDA No. 1/2020 Morais City Extension – I, Keelakurichi Village & Panchayat, Thiruverumbur Panchayat Union & Taluk, Tiruchirapallii District.

Structural Details Design by

TRICHY RG ENGINEERING EXCELLENCE
PRIVATE LIMITED

No. 64, Nandavanam Street,
LIC Colony
Trichy – 620021
Phone – 0431-4024691

STRUCTURAL DESIGN STABILITY CERTIFICATE.

I hereby certify thatThe Proposed Construction of Residential Building (Affordable Housing Project) in Old S.F.No. 205/5A, New S.F.No. 205/13, Plot No. 378 A in Approved Layout L.P (R) /NTDA No. 1/2020 Morais City Extension – I, Keelakurichi Village & Panchayat, Thiruverumbur Panchayat Union & Taluk, Tiruchirapallii District. The building will withstand against the Earthquake,(Seismic Zone II as per IS 1893 (Part I) 2002) loading stress parameters are within limits of National Building Code and Bureau of Indian standards code of practice for concrete and loading. The building consists of stilt +five floors. For external and internal partition walls 230/150/100thick A. A. C block work walls are used.

The R.C.C building frame of the structure is designed as per the Indian Standard code of practice for concrete and loading as follows:

1. IS: 456-2000 Code of Practice for Plain and Reinforced concrete

2. IS: 875-1987 Code of Practice for Design loads for Buildings and structures

3. IS: 1893-2002 Criteria for Earthquakes resistant design of structures Part-1 General Provisions and Buildings

4. IS: 4326-1993 Code of Practice for Earthquakes resistant design & Construction of Buildings.

5 .IS:13920-1993 Code of Practice for Ductile detailing of concrete structures subjected to seismic forces and

6. National Building code of India-2005.

It is further certified that the above structure will be constructed from foundation to roof, as per structural designs and detailing of reinforcements furnished in our drawings. The building will be safe and Sound as per the design.

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DESIGN BASIS REPORT

For

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1.0 OBJECTIVE

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The Building is designed for Stilt + Five floors. The structure is supported on column in turn resting on column footing Foundation. The Structural System comprises columns, beams, slabs and wall structure.

3-D Analysis of all the building structures will be carried out using STAAD PRO Software package and analysis results shall be used for designing the various elements.

2.0 DESIGN LOADS

2.1 Dead Loads

The Deadloads that are envisaged to act permanently are considered as per **IS:875 (Part 1) – 1987 – Dead loads.** Indian standard **" Code of Practice for Design Loads (other than earthquakes) for Buildings and Structures".**

1. Slab is assumed to be 125mm thick – 3.125 KN/m^2
2. Floor finish – 1.5KN/m^2
3. AAC Block masonry walls 200mm& 100mm thick are proposed to be used (location of walls per Architectural drawings) Unit weight is taken as 8 KN/m^3
4. Weathering course in Terrace finish –2 KN/m^2

2.2 Imposed Loads

The imposed loads that are envisaged to get permanently are considered as per **IS : 875 (part – 2) – 1987.** Indian standard **"Code of Practice for Design loads (other than earthquake) for Buildings and structures".**

1. Living = 2 KN/m^2
2. Staircase = 3 KN/m^2
3. Toilets = 2 KN/m^2
4. Terrace floors = 1.5 KN/m^2

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2.3 Earthquake Load

The loading due to earthquake is assessed based on the provisions of **IS :1893-2016.** Structures with ductile detailing is considered as per **IS: 13920-2016.**

Tiruchirapalli falls under Seismic Zone II

Zone factor **= 0.10**

Response reduction factor **= 3**

Importance factor **= 1.0**

Structure with ductile detailing is considered as per IS: 13920-2016

2.3 Load combinations

The various loads shall be combined in accordance with the stipulations in IS:875 (Part 5) – 1987. Whichever combinations produced the most unfavorable effect in the building, foundation or structural member concerned shall be adopted. The various load combinations considered in the analysis are as follows:

1. 1(DL + LL)
2. 1(DL + 0.8LL + 0.8 SQX + 1
3. 1(DL + 0.8LL + 0.8 SQX - 1
4. 1(DL + 0.8LL + 0.8 SQZ + 1
5. 1(DL + 0.8LL + 0.8 SQZ - 1
6. 1.0(DL + SQX + 1)
7. 1.0(DL + SQX - 1)
8. 1.0(DL + SQZ + 1)
9. 1.0(DL + SQZ - 1)
10. 1.5(DL + LL)
11. 1.5(DL + SQX + 1)
12. 1.5(DL + SQX - 1)
13. 1.5(DL + SQZ + 1)
14. 1.5(DL + SQZ – 1)
15. 1.2(DL + LL + SQX + 1)

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16. 1.2(DL + LL + SQX – 1)
17. 1.2(DL + LL + SQZ + 1)
18. 1.2(DL + LL + SQZ – 1)
19. 0.9DL + 1.5SQX + 1
20. 0.9DL + 1.5SQX – 1
21. 0.9DL + 1.5SQZ + 1
22. 0.9DL + 1.5SQZ - 1

The above load combination will be considered and effect of worst combinations will be taken for design of various building elements.

3.0 ANALYSIS METHODS

The analysis of the structures is carried out using the STAAD PRO. The entire super structure is modeled using frame elements as appropriate. Beams and columns are modeled as frame elements. Appropriate loads and its combinations as per relevant IS code clauses, for most unfavorable effects are chosen for design. Various load cases considered in the analysis are briefed above.

4.0 DESIGN ASSUMPTION

4.1.1 The Base of the Foundation is assumed to be FIXED& PINNED.

4.1.2 All concrete elements shall be designed in accordance with IS 456:2000 Limit state design.

4.1.3 Appropriate loads and its combination as per relevant clauses, for the most unfavorable effects are chosen for design. (Refer Load Combination below).

5.0 FOUNDATION DESIGN

Type of foundation : isolated columnfooting
Depth of foundation : 3.0m below natural ground level

6.0 MATERIALS

The self-weight of the various elements are computed based on the unit weight of materials as given below:

S. no	Materials	Unit weight KN / m^3
1	Reinforced Cement Concrete	25
2	AAC Block / Brick WORK(for lift wall& parapet)	8/20
3	Steel	78.50

Structural concrete shall be of grade M25 forall R.c.cwork.
Steel reinforcement shall be of grade Fe 500 confirming to IS : 1786-2008.

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7.0 NOMINAL COVER TO REINFORCEMENT

From Durability requirement, exposure condition is assumed as mild for structural elements above ground level and moderate for structural elements below ground level.

The clear cover to reinforcement to meet durability requirement shall be as follows:

Footing - 50mm

Column - 40mm

Beam- 32mm

Slab - 20mm

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FOOTING DESIGN CALCULATIONS

Footing No	:	FC21	
Column No	:	C21	(300 mm X 530 mm)
Analysis No	:	477	
Concrete Grade	:	M25	N/sqmm
Steel Grade	:	Fe500	N/sqmm
Clear Cover	:	50	mm
Df	:	3 M	
Dw	:	6 M	
Density of Soil	=	18	kN/cum
Soil Bearing Capacity	=	350	kN/sqm
Gross Bearing Capacity	=	404	kN/sqm
Permissible SBC Increase for EQ	=	50	%
Permissible SBC Increase for Wind	=	25	%
Live Load Reduction	=	50	%
Permissible area of loss of contact	=	0	%
Design cross section by	:	Factored SBC	
Factor	=	1.5	
Thus factored SBC	=	525	kN/sqm

Consider overburden pressure

Footing Type	:	Pad
Footing Size (L x B x D)	:	2350mm X 2100mm X 700mm

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Without considering Effect of Water Table

Footing Self Wt., F1	=	86.36	kN
Soil Weight, S1	=	197.73	kN
Total Weight, W1	=	F1 + S1	
	=	284.09	kN
Offset Along L (Loff)	=	910	mm
Offset Along B (Boff)	=	900	mm

Check For Maximum Soil Pressure:

Critical Load Combination	=	[1] : (LOAD 1: LOAD CASE 1 SELF WEIGHT) +(LOAD 2: LOAD CASE 2 WALL LOAD) +(LOAD 3: LOAD CASE 3 DEAD LOAD) +(LOAD 7: LOAD CASE 7 ONE WAY DEAD) +(LOAD 4: LOAD CASE 4 LIVE LOAD) +(LOAD 8: LOAD CASE 8 ONE WAY LIVE)	
Pcomb	=	1655.49	kN
P	=	Pcomb + W1	
P	=	1939.58	kN
Mx	=	0	kNm
My	=	0	kNm
P/A	=	393.03	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Maximum Soil Pressure	=	393.03	kN/sqm
Allowable Soil Pressure	=	(1 X 350) + 54	kN/sqm
	=	404	kN/sqm

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Check For Minimum Soil Pressure:

Critical Load Combination	=	[1] : (LOAD 1: LOAD CASE 1 SELF WEIGHT) +(LOAD 2: LOAD CASE 2 WALL LOAD) +(LOAD 3: LOAD CASE 3 DEAD LOAD) +(LOAD 7: LOAD CASE 7 ONE WAY DEAD) +(LOAD 4: LOAD CASE 4 LIVE LOAD) +(LOAD 8: LOAD CASE 8 ONE WAY LIVE)	
Pcomb	=	1655.49	kN
P	=	Pcomb + W1	
P	=	1939.58	kN
Mx	=	0	kNm
My	=	0	kNm
P/A	=	393.03	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Minimum Soil Pressure	=	393.03	kN/sqm
	>	0	

Check For Buoyancy:

Depth of Water Table is below Depth of Foundation, hence Buoyancy check Not Applicable

Check For Sliding:

Critical Load Combination	=	[1] : (LOAD 1: LOAD CASE 1 SELF WEIGHT) +(LOAD 2: LOAD CASE 2 WALL LOAD) +(LOAD 3: LOAD CASE 3 DEAD LOAD) +(LOAD 7: LOAD CASE 7 ONE WAY

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		DEAD) +(LOAD 4: LOAD CASE 4 LIVE LOAD) +(LOAD 8: LOAD CASE 8 ONE WAY LIVE)	
Coefficient Of Friction	=	0.4	
Factor of safety	=	1.2	
Pcomb	=	1655.49	
Shear Vx	=	0.20	kN
shear Vy	=	12.05	kN
Resultant sliding force	=	12.05	kN
Downward force	=	Pcomb + (F1 + S1)	
	=	1939.58	kN
Upward water pressure	=	0.00	kN
Net downward force	=	1939.58	kN
Force resisting sliding	=	Friction Coeff X Net Downward Force	
	=	775.83	kN
Factor of safety available	=	Resisting Force / Sliding Force	
	=	64.40	
	>	1.2	

Check For Overturning:

Along Width:

Critical Load Combination	=	(LOAD 1: LOAD CASE 1 SELF WEIGHT) +(LOAD 2: LOAD CASE 2 WALL LOAD) +(LOAD 3: LOAD CASE 3 DEAD LOAD) +(LOAD 7: LOAD CASE 7 ONE WAY DEAD) +(LOAD 4: LOAD CASE 4 LIVE LOAD) +(LOAD 8: LOAD CASE 8 ONE WAY LIVE)	
Factor of safety	=	1.50	

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Pcomb	=	1655.49	kN
Moment Mx	=	0	kNm
P	=	Pcomb + (F1 + S1)	
	=	1939.58	kN
Stabilizing Moment for P	=	2279.01	kNm
DeStabilizing Moment	=	0	kNm
	=	Hence, Not required	

Along Length:

Critical Load Combination	=	(LOAD 1: LOAD CASE 1 SELF WEIGHT) +(LOAD 2: LOAD CASE 2 WALL LOAD) +(LOAD 3: LOAD CASE 3 DEAD LOAD) +(LOAD 7: LOAD CASE 7 ONE WAY DEAD) +(LOAD 4: LOAD CASE 4 LIVE LOAD) +(LOAD 8: LOAD CASE 8 ONE WAY LIVE)
Factor of safety	=	1.50
Pcomb	=	1655.49 kN
Moment My	=	0 kNm
P	=	Pcomb + (F1 + S1)
	=	1939.58 kN
Stabilizing Moment for P	=	2036.56 kNm
DeStabilizing Moment	=	0 kNm
	=	Hence, Not required

Design For Bending:

Bottom Reinforcement Along L:

Deff	=	642	mm

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Beff	=	2100	mm
SPu	=	606	kN/sqm
Mu	=	SPu X B X Loff X Loff / 2	
	=	526.92	kNm
Pt	=	0.144	%
AstRqd (BM)	=	1943	sqmm
Ast Prv (Distributed Across Total Width)	=	18 - Y12 @ 125	
	=	2036	sqmm

Top Reinforcement Along L:

D	=	700	mm
	<=	1000	mm, Hence
Ast	=	Min Pt For Top Reinforcement X D X B	
	=	0.06% X 700 X 2100	
	=	882	sqmm
Ast Prv (Distributed Across Total Width)	=	12 - Y10 @ 195 c/c	
	=	942	sqmm

Bottom Reinforcement Along B:

Deff	=	626	mm
Leff	=	2350	mm
SPu	=	606	kN/sqm
Mu	=	SPu X L X Boff X Boff / 2	
	=	576.76	kNm

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Pt	=	0.148	%
AstRqd (BM)	=	2183	sqmm
Ast Prv (Distributed Across Total Length)	=	20 - Y12 @ 125	
	=	2262	sqmm

Top Reinforcement Along B:

D	=	700	mm
	<=	1000	mm, Hence
Ast	=	Min Pt For Top Reinforcement X D X L	
	=	0.06% X 700 X 2350	
	=	987	sqmm
Ast Prv (Distributed Across Total Length)	=	13 - Y10 @ 200 c/c	
	=	1021	sqmm

Design For Shear:

One Way Shear Along L:

Critical Section @ d from Column Face

	=	642	mm
Deff	=	642	mm
Beff	=	2100	mm
SPu	=	606	kN/sqm
Vu	=	SPu X (Loff - d) X B	
	=	341.06	kN
Tv	=	Vu / (Beff X Deff)	

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	=	0.25	N/sqmm
Tc	=	0.29	N/sqmm
Tv	<	Tc	

One Way Shear Along B:

Critical Section @ d from Column Face

	=	626	mm
Deff	=	626	mm
Leff	=	2350	mm
SPu	=	606	kN/sqm
Vu	=	SPu X (Boff - d) X L	
	=	390.20	kN
Tv	=	Vu / (Leff X Deff)	
	=	0.27	N/sqmm
Tc	=	0.29	N/sqmm
Tv	<	Tc	

Design For Punching Shear:

Critical Section @ d/2 from Column Face

	=	317	mm
Deff	=	634	mm
Leff	=	1164	mm

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Beff	=	934	mm
Punching Perimeter	=	4196	mm
Punching Area	=	2660264	sqmm
SPu	=	Factored SBC	
	=	606	kN/sqm
Vu	=	SPu X ((L X B)-(Leff X Beff))	
	=	2331.78	kN
Tv	=	Vu / Punching Area	
	=	0.877	N/sqmm
Tc	=	1.25	N/sqmm
Tv	<	Tc	

Load Transfer Check For Load Transfer From Column To Footing

Critical Load Combination	=	[2] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)	
Pu	=	2483.24	kN
A2	=	0.16	sqm
A1	=	10.32	sqm
Base Area	=	4.94	sqm
A1	>	Base Area	
Thus, A1	=	4.94	

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Modification Factor	=	SquareRoot(A1/A2) < = 2
SquareRoot(A1/A2)	=	5.5565
Thus, Modification Factor	=	2
Concrete Bearing Capacity	=	0.45 X Fck X Modification Factor X Column Area
	=	3577.5 kN
Concrete Bearing Capacity	>	Pu, Hence Safe.

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COLUMN DESIGN CALCULATIONS

General Data

Column No.	:	C21	
Level	:	0 m To 1.829 m	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe500	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	300	mm
Column D	=	530	mm
Clear Cover	=	32	mm
Clear Floor Height @ B	=	1449	mm
Clear Floor Height @ D	=	1449	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	Simultaneously (Both Axis)	
Code defined D/B ratio	:	4	
D/B Ratio	:	1.77 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	477
Load Combination	=	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4

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		LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)	
Critical Location	=	Bottom Joint	
Pu	=	2483.24	kN
Mux	=	0	kNm
Muy	=	0	kNm
Vux	=	0.29	kN
Vuy	=	-18.07	kN

Minimum Eccentricity Check

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

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	20.56	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	51.07	kNm

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	12.9	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	49.66	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	4.83	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	2.73, Column not Slender Along D	

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Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1
Slenderness Ratio	=	Effective Length / B
	=	4.83, 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	0	51.07	51.07	0	51.07
Minor Axis - Muy	0	49.66	49.66	0	49.66

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	=	2483.24	kN
Mux	=	51.07	kNm
Muy	=	49.66	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	2.23
Reinforcement Provided	=	10-Y20 + 2-Y16

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Reg. No. SE - Gr -II / DTCP / TRICHY / MAY2024 / 009
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Plot No. 64, Nandavanam Street,
LIC Colony, Trichy - 620 021.

Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	44.2	deg
MRes	=	71.23	kNm
MCap	=	103.09	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.69 <= 1	

Shear Calculation	Along D	Along B
Critical Load Combination	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)
Design shear force, Vu (kN)	-18.0691	0.2939
Pu (kN)	2472.96	2472.96
Deff ,Beff (mm)	488	258
Aeff (sqmm)	146400	136740
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.1234	0.0021
Pt (%)	1.114	1.114
Design shear strength, Tc (N/sqmm)	0.6676	0.6676
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	3.027	3.1702
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	1.0014	1.0014

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Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links 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	
	=	5	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	256	mm
Min. dimension of column	=	300	mm
Max. 300 mm	=	300	mm
Provided spacing	=	200	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	200	---	---	200	---

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Level	:	**1.829 m To 5.729 m**	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe500	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	300	mm
Column D	=	530	mm
Clear Cover	=	32	mm
Clear Floor Height @ B	=	3900	mm
Clear Floor Height @ D	=	3300	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	Simultaneously (Both Axis)	
Code defined D/B ratio	:	4	
D/B Ratio	:	1.77 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	432
Load Combination	=	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)
Critical Location	=	Top Joint

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Pu	=	2390.35	kN
Mux	=	-102.74	kNm
Muy	=	0.8	kNm
Vux	=	0.04	kN
Vuy	=	37.09	kN

Minimum Eccentricity Check

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

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	24.27	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	58.01	kNm

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	17.8	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	47.81	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	13	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.23, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

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Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	13, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	60.6	kNm

Design slenderness moment along B

Puz	=	3077.78	kN
Pb	=	852.93	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	0.31 < = 1, Hence k=0.31	
Mslndy	=	k x 60.6	
	=	18.72	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	-102.74	58.01	-102.74	0	-102.74
Minor Axis - Muy	0.8	47.81	47.81	18.72	66.53

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	=	2390.35	kN
Mux	=	-102.74	kNm

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Muy	=	66.53	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	2.23	
Reinforcement Provided	=	10-Y20 + 2-Y16	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	32.93	deg
MRes	=	122.4	kNm
MCap	=	126.54	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.97 <= 1	

Shear Calculation	Along D	Along B
Critical Load Combination	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)
Design shear force, Vu (kN)	37.093	0.0448
Pu (kN)	2390.35	2390.35
Deff ,Beff (mm)	488	258
Aeff (sqmm)	146400	136740
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.2534	0.0003
Pt (%)	1.114	1.114
Design shear strength, Tc (N/sqmm)	0.6676	0.6676
Shear Strength Enhancement Factor	1 + 3 x Pu / (B x D x Fck)	

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(Compressive Force)		
	2.9593	3.0977
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	1.0014	1.0014
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links 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

= 5 mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16 = 256 mm

Min. dimension of column = 300 mm

Max. 300 mm = 300 mm

Provided spacing = 200 mm

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Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	200	---	---	200	---

Level	:	**5.729 m To 8.729 m**	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe500	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	300	mm
Column D	=	530	mm
Clear Cover	=	32	mm
Clear Floor Height @ B	=	3000	mm
Clear Floor Height @ D	=	2400	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	Simultaneously (Both Axis)	
Code defined D/B ratio	:	4	
D/B Ratio	:	1.77 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	978
Load Combination	=	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)

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Critical Location	=	Bottom Joint	
Pu	=	1962.06	kN
Mux	=	108.01	kNm
Muy	=	0.99	kNm
Vux	=	-0.17	kN
Vuy	=	72.56	kN

Minimum Eccentricity Check

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

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	22.47	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	44.08	kNm

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	16	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	39.24	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	10	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	4.53, Column not Slender Along D	

Column Is Unbraced Along B

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Slenderness Check Along B:

Effective Length Factor	=	1
Slenderness Ratio	=	Effective Length / B
	=	10, 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	108.01	44.08	108.01	0	108.01
Minor Axis - Muy	0.99	39.24	39.24	0	39.24

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	=	1962.06	kN
Mux	=	108.01	kNm
Muy	=	39.24	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	1.41
Reinforcement Provided	=	10-Y16 + 2-Y12
Load Angle	=	Tan^{-1}(Muy/Mux)

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	=	19.97	deg
MRes	=	114.91	kNm
MCap	=	122.22	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.94 <= 1	

Shear Calculation	Along D	Along B
Critical Load Combination	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)	[1] : 1.5 (LOAD 1: LOAD CASE 1 SELF WEIGHT) +1.5 (LOAD 2: LOAD CASE 2 WALL LOAD) +1.5 (LOAD 3: LOAD CASE 3 DEAD LOAD) +1.5 (LOAD 7: LOAD CASE 7 ONE WAY DEAD) +1.5 (LOAD 4: LOAD CASE 4 LIVE LOAD) +1.5 (LOAD 8: LOAD CASE 8 ONE WAY LIVE)
Design shear force, Vu (kN)	72.5646	-0.167
Pu (kN)	1950.82	1950.82
Deff ,Beff (mm)	490	260
Aeff (sqmm)	147000	137800
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.4936	0.0012
Pt (%)	0.703	0.703
Design shear strength, Tc (N/sqmm)	0.5605	0.5605
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.5925	2.6988
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5

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Enhanced shear strength, Tc-e (N/sqmm)	0.8408	0.8408
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links 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
Provided spacing	=	175	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

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BEAM DESIGN CALCULATION

Beam No	: SB09	
Analysis Reference (Member)	659 : (8.729 m)	
Beam Length	: 1500	mm
Breadth (B)	: 200	mm
Depth (D)	: 530	mm
Effective Depth (d)	: 468	mm
Design Code	: IS 456	
Beam Type	: Cantilever Beam	
Grade Of Concrete (Fck)	: M25	N/sqmm
Grade Of Steel (Main)	: Fe500	N/sqmm
Grade Of Steel (Shear)	: Fe500	N/sqmm
Top/Bottom Clear Cover (Cmin)	: 32	mm
Side Clear Cover	: 32	mm
Es	: 2x10^5	N/sqmm
Ptnominal (%) (Bn)	: 0.2	%

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Flexure Design						
	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - RCDC	1	-	-	1	1	1
Mu (kNm)	1.99	-	-	24.01	84.53	121.04
Tu (kNm)	0	0	0	0	0	0
M_{Tu} (kNm)	0	0	0	0	0	0
Mud (kNm)	1.99	0	0	24.01	84.53	121.04
MuLim (kNm)	146	146	146	146	146	146
R	0.045	0	0	0.548	1.93	2.763
Ptmin (%) (A)	0.2	0.2	0.2	0.2	0.2	0.2
Ptclc (%) (B')	0.2	0.2	0.2	0.2	0.492	0.747
Pcclc (%) (C)	0	0	0	0	0	0
PtPrv (%)	0.242	0.242	0.242	1.049	1.049	1.049
AstCalc (sqmm)	187.2	187.2	187.2	187.2	460.8	699.66
AstPrv (sqmm)	226.2	226.2	226.2	981.74	981.74	981.74
Reinforcement Provided	2-Y12	2-Y12	2-Y12	2-Y25	2-Y25	2-Y25

Note: Calculation of Ast

AstCalc = Max {B',C} x B X d (for Mu > 0)

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AstCalc = Bn x B X d (for Mu = 0)

Where,

A	= Ptmin	=	Min % area of flexural reinforcement
B'	= Ptclc	=	Maximum of % reinforcement required for Bending Moment and Min % area of flexural reinforcement (A)
Bn	= Ptnominal	=	Nominal % area of reinforcement
C	= Pcclc	=	% area of compression reinforcement required
D	= AstCrack	=	Area of reinforcement required for Crackwidth

Shear Design			
	Left	Mid	Right
Critical L/C - RCDC	1	1	1
PtPrv (%)	1.049	1.049	1.049
Vu (kN)	75.26	85.95	104.26
Tu (kNm)	0	0	0
V_{Tu} (kN)	0	0	0
Vut (kN)	75.26	85.95	104.26
Tv (N/sqmm)	0.8	0.92	1.11
Tc (N/sqmm)	0.65	0.65	0.65
Vc (kN)	61.11	61.11	61.11
Vus=Vut-Vc (kN)	14.15	24.84	43.15
Legs	2	2	2

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Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	-	-	-
Asv Torsion Prv (sqmm)	-	-	-
AsvReqd (sqmm/m)	221.58	221.58	255.4
SvCalc (mm)	200	200	200
SvPrv (mm)	200	200	200
Asv Total Prv (sqmm)	502.7	502.7	502.7

Maximum Spacing Criteria

Basic

Spc1 =0.75d = 351 mm

Spc2 = 300 mm

SFR Design

Beam Width = 200 mm

Beam Depth = 530 mm

Web Depth = 530 <= 750 mm

Side Face Reinforcement not required.

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Analysis Reference (Member)	:	667,651 (8.729 m)	
Beam Length	:	4416	mm
Breadth (B)	:	200	mm
Depth (D)	:	530	mm
Effective Depth (d)	:	468	mm
Design Code	:	IS 456	
Beam Type	:	Regular Beam	
Grade Of Concrete (Fck)	:	M25	N/sqmm
Grade Of Steel (Main)	:	Fe500	N/sqmm
Grade Of Steel (Shear)	:	Fe500	N/sqmm
Top/Bottom Clear Cover (Cmin)	:	32	mm
Side Clear Cover	:	32	mm
Es	:	2x10^5	N/sqmm
Ptnominal (%) (Bn)	:	0.2	%

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Flexure Design						
	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - RCDC	-	1	1	1	1	1
Mu (kNm)	-	75.23	9.72	106.34	10.08	88.82
Tu (kNm)	0	0	0	0	0	0
M_{tu} (kNm)	0	0	0	0	0	0
Mud (kNm)	0	75.23	9.72	106.34	10.08	88.82
MuLim (kNm)	146	146	146	146	146	146
R	0	1.717	0.222	2.428	0.23	2.028
Ptmin (%) (A)	0.2	0.2	0.2	0.2	0.2	0.2
Ptclc (%) (B')	0.2	0.432	0.2	0.641	0.2	0.521
Pcclc (%) (C)	0	0	0	0	0	0
PtPrv (%)	0.242	0.483	0.242	1.049	0.242	0.671
AstCalc (sqmm)	187.2	404.69	187.2	599.51	187.2	487.3
AstPrv (sqmm)	226.2	452.4	226.2	981.74	226.2	628.32
Reinforcement Provided	2-Y12	2-Y12 2-Y12	2-Y12	2-Y25	2-Y12	2-Y20

Note: Calculation of Ast

AstCalc = Max (B',C) x B X d (for Mu > 0)

AstCalc = Bn x B X d (for Mu = 0)

Where,

A = Ptmin = Min % area of flexural reinforcement

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B'	= Ptclc	=	Maximum of % reinforcement required for Bending Moment and Min % area of flexural reinforcement (A)
Bn	= Ptnominal	=	Nominal % area of reinforcement
C	= Pcclc	=	% area of compression reinforcement required
D	= AstCrack	=	Area of reinforcement required for Crackwidth

Shear Design			
	Left	Mid	Right
Critical L/C - RCDC	1	1	1
PtPrv (%)	1.049	0.483	0.671
Vu (kN)	119.42	104.78	112.72
Tu (kNm)	0	0	0
V_{Tu} (kN)	0	0	0
Vut (kN)	119.42	104.78	112.72
Tv (N/sqmm)	1.28	1.12	1.2
Tc (N/sqmm)	0.65	0.48	0.55
Vc (kN)	61.11	45.13	51.51
Vus=Vut-Vc (kN)	58.31	59.65	61.21
Legs	2	2	2
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	-	-	-
Asv Torsion Prv (sqmm)	-	-	-

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AsvReqd (sqmm/m)	345.1	353.04	468.04
SvCalc (mm)	200	200	200
SvPrv (mm)	200	200	200
Asv Total Prv (sqmm)	502.7	502.7	502.7

Maximum Spacing Criteria

Basic

Spc1 =0.75d = 351 mm

Spc2 = 300 mm

SFR Design

Beam Width = 200 mm

Beam Depth = 530 mm

Web Depth = 530 <= 750 mm

Side Face Reinforcement not required.

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Design of slab

Four Edges Discontinuous		
Fck	25	N/mm^2
Fy	500	N/mm^2
Dia of bar (Lx Direction)	8	mm
Dia of bar (Ly Direction)	8	mm
Clear cover	15	mm
Clear span Lx	2943	mm
Clear span Ly	3650	mm
Width of Beam	200	mm
Slab tk	125	mm
Floor Finish	45	mm
Weathering Coarse	5	mm
LIVE LOAD	4	KN/m2
Length of slab (lx)	3049	mm
Length of slab (ly)	3752	mm
Dead Load	4.08	KN/m2
LIVE LOAD	4	KN/m2
FD D.L	6.12	KN/m2
FD L.L	6	KN/m2
ly/lx	1.2402	IT IS TWO WAY SLAB

Bending Moment Coeffecient for Rectangular Panels Supported on Four Sides with Provision for Torsion at Corners (IS 456-2000 Table 26)

	short span		long span	
	(-ve Mx)	(+ve Mx	(-ve My)	(+ve My)
	0	0.0879	0	0.057122

support moment	Mx	0	KN.m
	My	0	KN.m
span moment	Mx	9.8998	KN.m
	My	6.4361	KN.m

Xu max/d	0.46	
Q	3.3402	
d rquired	54.442	The depth provide is suffcient
Effective depth shorter span	106	
Effective depth longer span	98	
Ast (+ ve Shorter span)	224.3	mm^2
Ast (+ ve Longerer span)	156.02	mm^2
Ast (- ve Shorter span)	0	mm^2
Ast (- ve Longerer span)	0	mm^2
Min Ast	150	mm^2

SPAN REINFORCEMENT

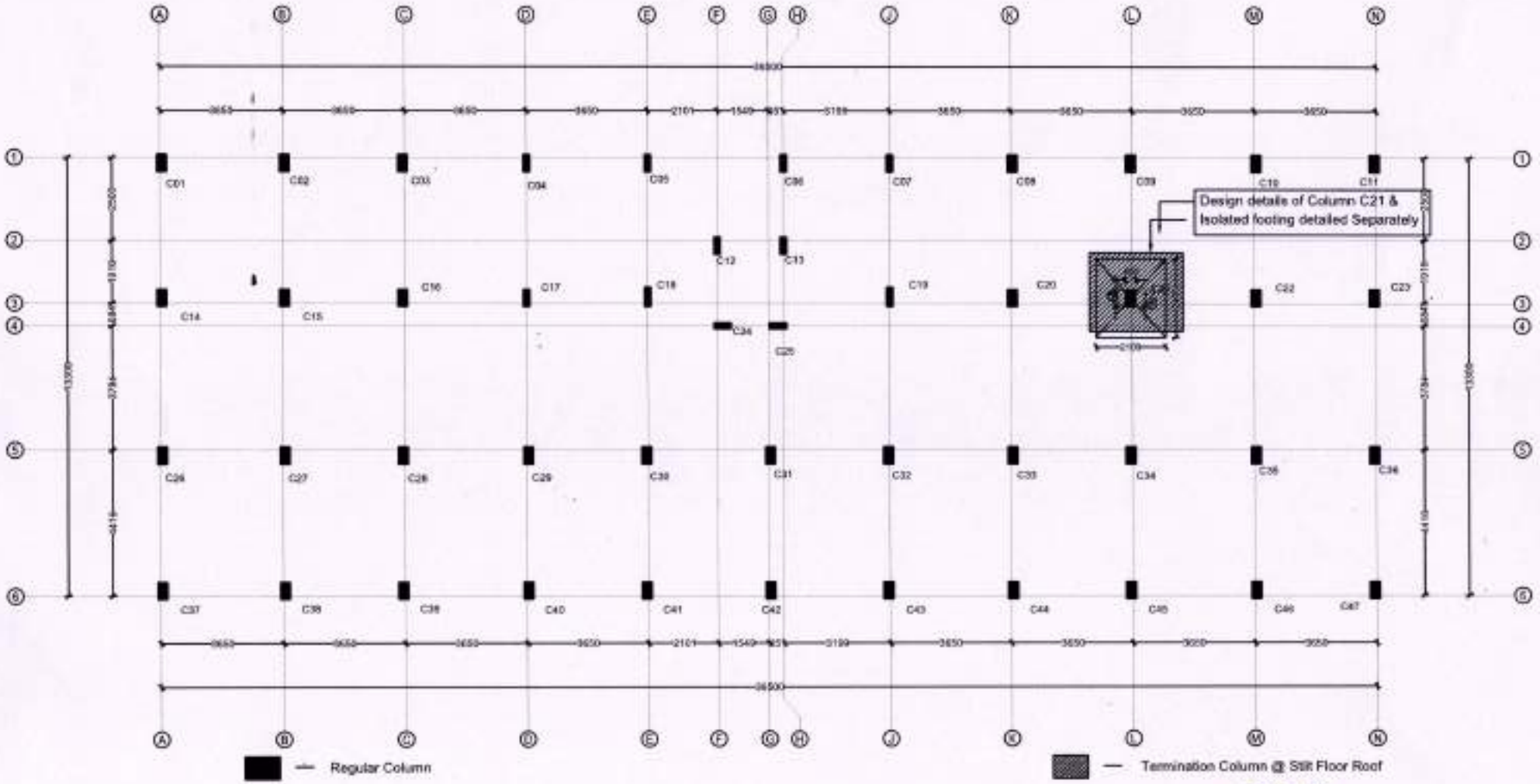
TO PROVIDE 8 mm DIA OF BAR @224 mm SPACING IN 2943 mm DIRECTION

TO PROVIDE 8 mm DIA OF BAR @294 mm SPACING IN 3650 mm DIRECTION

SUPPORT REINFORCEMENT

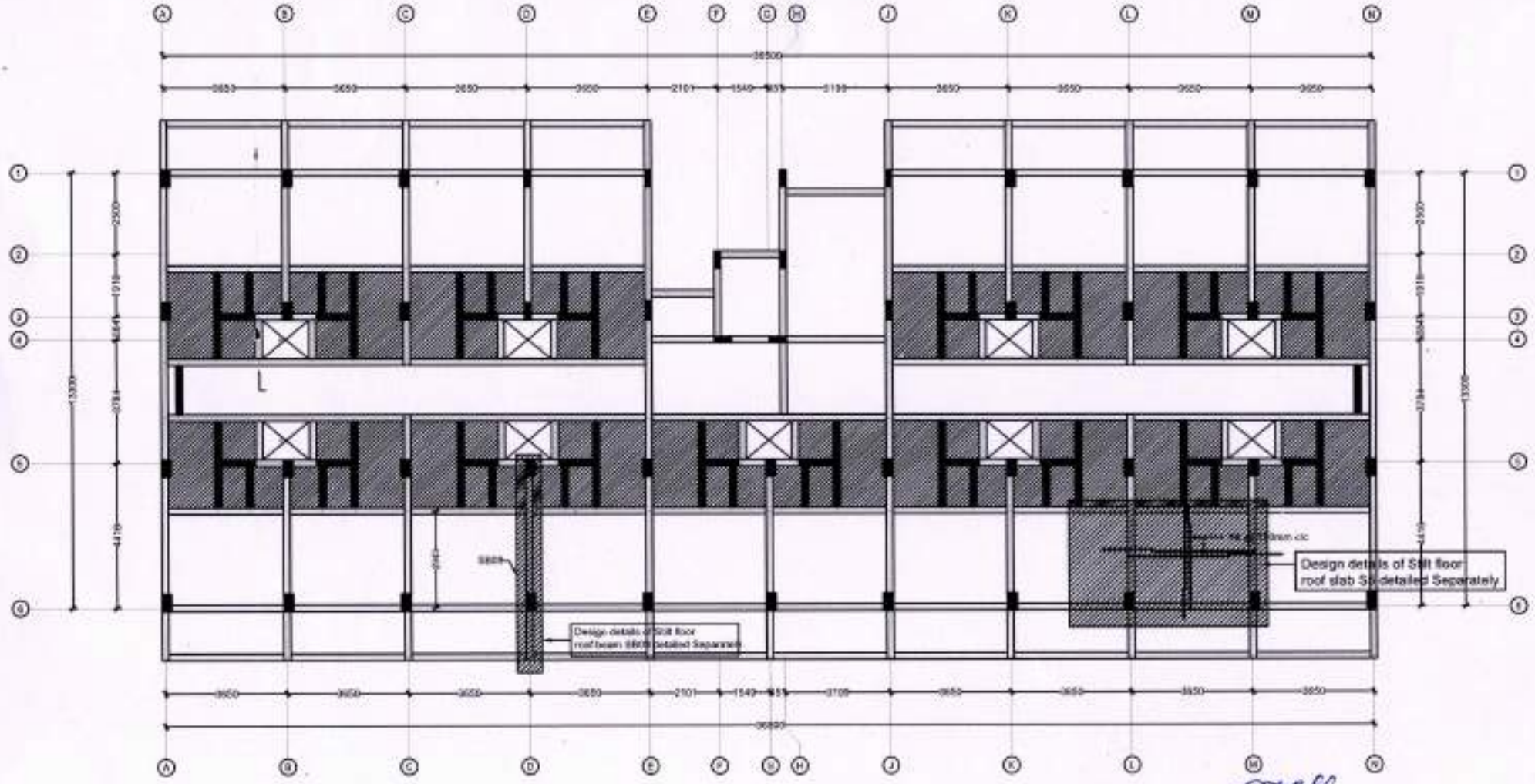
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Column & Grid Layout



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Stilt Roof Beam Layout



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