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STRUCTURAL STABILITY CERTIFICATE

Project Name : STILT + 03 FLOORS – PORUR, CHENNAI.

Location : PLAN SHOWING THE PROPOSED CONSTRUCTION OF STILT + 3 FLOORS COMMERCIAL BUILDING WITH 3 DWELLING UNITS AT SURVEY NO.4/3A10, PORUR VILLAGE, PLOT NO.7, SAPTHAGIRI NAGAR, PORUR, CHENNAI.

Type of structure: R.C.C Framed Structure

- Material Used:

  For Concrete M40 and for steel Structure Fe 500

- The loading is taken as per the requirements of Code of practice IS-875
- Wind forces as per the latest code IS-875 part III
- Seismic Force as per the latest code IS 1893
- The design of the Structure is done as per the latest code IS-456.

Structure analysis & design:

The structure is analyzed as a Space frame structure in ETAB. Footings, Columns, Lift lobby slabs, Staircase are designed as conventional beam and slab.

Accordingly, we hereby issue the **Structure is "Sound and Safe".**

Accordingly, we hereby issue the **'Structural Stability Certificate'**

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REPORT ON THE PROPOSED CONSTRUCTION OF STILT +3 FLOORS COMMERCIAL BUILDINGS AT SURVEY NO.4/3A10, PORUR VILLAGE, PLOT NO.7, SAPTHAGIRI NAGAR, PORUR.

AS BUILT SUBMITTED

RAAGAVAN STTRUCTURAL DESIGNS LLP
Old No.24, New, No.11, X-Block, 5th St, X Block, Tower Park,
Anna Nagar, Chennai 600040

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INTRODUCTION

It has been proposed commercial building at PORUR, CHENNAI. The "Detailed Analysis and Design work of the building to RAAGAVAN STTRUCTURAL DESIGNS LLP. This report deals with the detailed analysis and design of commercial building at PORUR, CHENNAI.

GEOMETRY

This building is a R.C.C Structure. The building consists of Stilt +Three Floors only. The usage of the building is for Commercial purpose.

MATERIAL

Reinforced cement concrete
Grade of concrete - M 40 (Nominal Mix)
Grade of steel - Fe500

LOADINGS

a. Dead load

Unit weight of concrete = 25 kN/m^3
Unit weight of brickwork = 20 kN/m^3
Weathering course = 1.2 kN/m^2

b. Live load

Live load on Floor = 5.00 kN/m^2
Live load on Staircase & Passage = 3.00 kN/m^2
Live load on toilet = 2.00 kN/m_2
Live load on balcony = 3.00 kN/m_2
(Clause 4.1, Table 2, IS 875 – Part 2)

All other dead & live loads are given as gravity loads. The detailing of reinforcement is done as per IS 456-2000 and SP 16. The entire structure is analyzed for each loads and load combinations.

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LOAD COMBINATIONS:

1.0 1.0 DEAD LOAD+ 1.0 LIVE LOAD+ 1.0 ROOF LIVE LOAD

2.0 1.0 DEAD LOAD + 1.0 EQX

3.0 1.0 DEAD LOAD- 1.0 EQX

4.0 1.0DEAD LOAD + 1.0 EQZ

5.0 1.0 DEAD LOAD-1.0 EQZ

6.0 1.0 DEAD LOAD + 1.0 WX

7.0 1.0 DEAD LOAD- 1.0 WX

8.0 1.0 DEAD LOAD + 1.0 WY

9.0 1.0 DEAD LOAD-1.0 WY

10.0 1.0 DEAD LOAD +0.8 LIVE LOAD + 0.8 ROOF LIVE LOAD+ 0.8 EQX

11.0 1.0 DEAD LOAD +0.8 LIVE LOAD + 0.8 ROOF LIVE LOAD- 0.8 EQX

12.0 1.0 DEAD LOAD + 0.8 LIVE LOAD +0.8ROOF LIVE LOAD+ 0.8 EQZ

13.0 1.0 DEAD LOAD + 0.8 LIVE LOAD +0.8ROOF LIVE LOAD- 0.8 EQZ

14.0 1.0 DEAD LOAD +0.8 LIVE LOAD + 0.8 ROOF LIVE LOAD+ 0.8 WX

15.0 1.0 DEAD LOAD +0.8 LIVE LOAD + 0.8 ROOF LIVE LOAD- 0.8 WX

16.0 1.0DEAD LOAD + 0.8 LIVE LOAD +0.8ROOF LIVE LOAD+ 0.8 WY

17.0 1.0 DEAD LOAD + 0.8 LIVE LOAD +0.8ROOF LIVE LOAD- 0.8 WY

18.0 1.5 DEAD LOAD + 1.5 LIVE LOAD+1.5 ROOF LIVE LOAD

19.0 1.2 DEAD LOAD + 1.2 LIVE LOAD +1.2 ROOF LIVE LOAD+ 1.2 EQX

20.0 1.2 DEAD LOAD + 1.2 LIVE LOAD+1.2 ROOF LIVE LOAD - 1.2 EQX

21.0 1.2 DEAD LOAD + 1.2 LIVE LOAD +1.2 ROOF LIVE LOAD + 1.2 EQZ

22.0 1.2 DEAD LOAD + 1.2 LIVE LOAD+1.2 ROOF LIVE LOAD - 1.2 EQZ

23.0 1.2 DEAD LOAD + 1.2 LIVE LOAD +1.2 ROOF LIVE LOAD+ 1.2 WX

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24.0 1.2 DEAD LOAD + 1.2 LIVE LOAD+1.2 ROOF LIVE LOAD - 1.2 WX

25.0 1.2 DEAD LOAD + 1.2 LIVE LOAD +1.2 ROOF LIVE LOAD + 1.2 WY

26.0 1.2 DEAD LOAD + 1.2 LIVE LOAD+1.2 ROOF LIVE LOAD - 1.2 WY

27.0 1.5 DEAD LOAD + 1.5 EQX

28.0 1.5 DEAD LOAD -1.5 EQX

29.0 1.5 DEAD LOAD + 1.5 EQZ

30.0 1.5 DEAD LOAD - 1.5 EQZ

31.0 1.5 DEAD LOAD + 1.5 WX

32.0 1.5 DEAD LOAD -1.5 WX

33.0 1.5 DEAD LOAD + 1.5 WZ

34.0 1.5 DEAD LOAD - 1.5 WZ

35.0 0.9 DEAD LOAD + 1.5 EQX

36.0 0.9 DEAD LOAD - 1.5 EQX

37.0 0.9 DEAD LOAD + 1.5 EQZ

38.0 0.9 DEAD LOAD - 1.5 EQZ

39.0 0.9 DEAD LOAD + 1.5 WX

40.0 0.9 DEAD LOAD - 1.5 WX

41.0 0.9 DEAD LOAD + 1.5 WZ

42.0 0.9 DEAD LOAD - 1.5 WZ

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ANALYSIS

The entire analysis is carried out using finite element package program ETAB package for Commercial building as per approval drawing. The beams and columns are modeled as frame elements and the slabs are modeled as shell element. Raft foundation is adopted based on SBC of 210kN/m2 and the columns are assumed to be fixed at the base. Dead loads are considered as per IS 875 Part 1 and Live loads are considered as per IS 875 Part 2 and are applied as Line load and Area load.

Yours sincerely,

S. Skumaran

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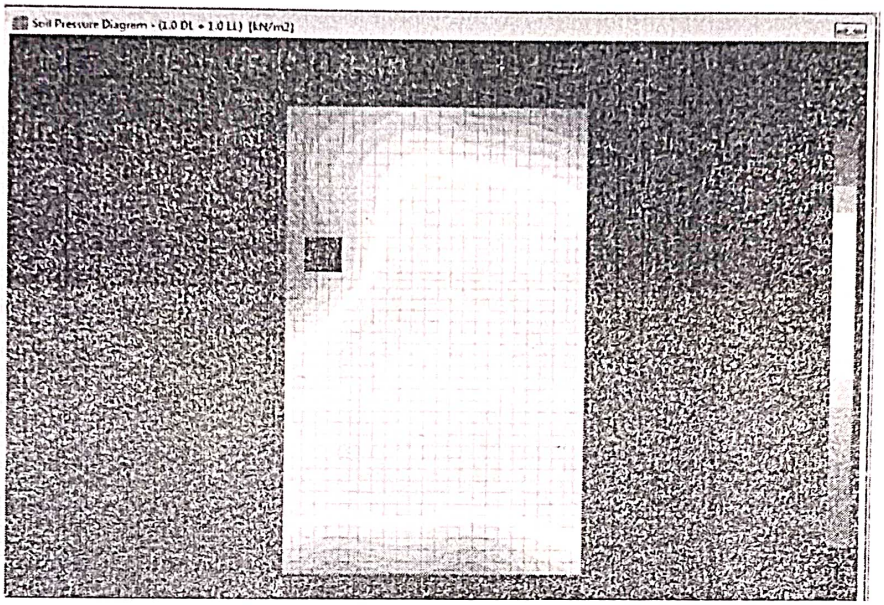
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FOOTING DESIGN CALCULATIONS

Project Name	:	ARCOT ROAD
Client Name	:	Mr.HEMANTH RAJ
Engineer Name	:	NSS
Design File	:	E:\SANDHYA\ARCOT ROAD\FOOTING
Analysis File	:	E:\ SANDHYA\ARCOT ROAD\SAFE
Analysis Last Modified	:	15-04-2023 10:02:08

The raft footing is provided for 1000mm thickness. The maximum base pressure is 13T/sq.m which is less than as 21T/sq.m. as per soil report (soil report- TJE/001168/2018).

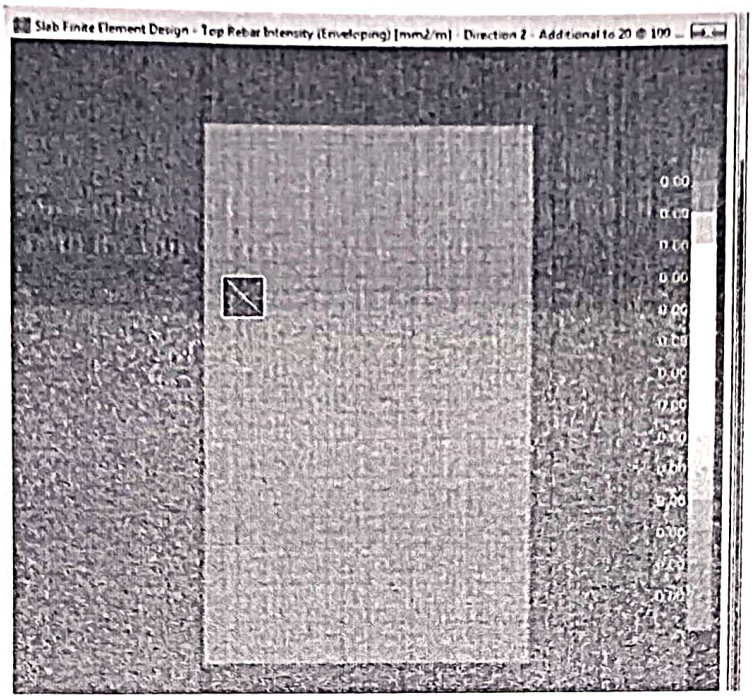


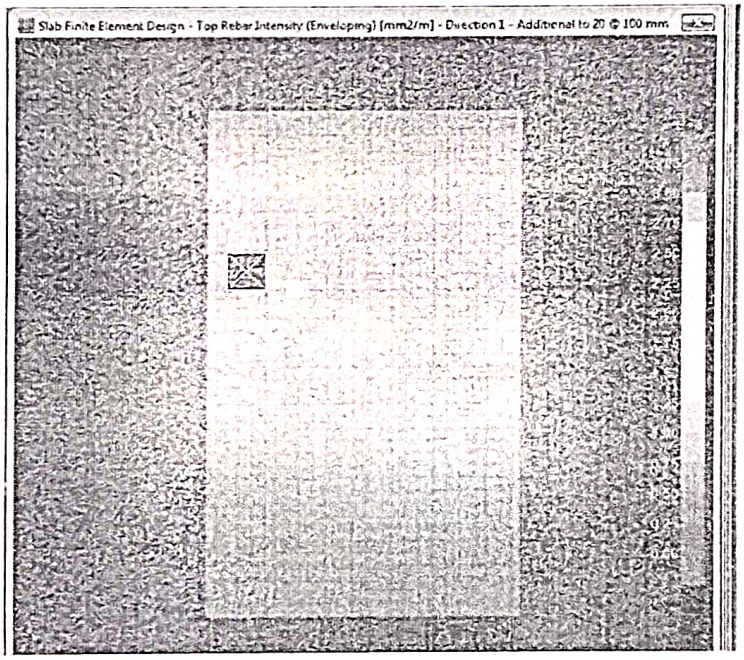
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Reinforcement provided for raft footing is T16 @150mm c/c along the both the direction.
And T20@ 100mm c/c along both the direction near shear wall.





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COLUMN DESIGN CALCULATIONS

Project Name	:	ARCOT ROAD
Client Name	:	Mr.HEMANTH RAJ
Engineer Name	:	NSS
Analysis File	:	E:\SANDHYA\ARCOT ROAD\ETAB\ MDB\Arcot_road_R6_03.02.23.mdb
Analysis Last Modified	:	03-Feb-23 10:01:44 AM

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	$\varepsilon 1$	=	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

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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)
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
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)

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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

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

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15	Multiplying factor to Beam Stiffness for effective length calculation	:	SP 24 1983 APPENDIX D

IS 13920

	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

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)	
Base to STILT	EQX	3	29815.655	0.918	1169.865	0.008	Non Sway
STILT to 1ST	EQX	3.5	28500.823	2.607	1169.865	0.018	Non Sway
1ST to 2ND	EQX	3.3	21636.497	3.48	1135.271	0.02	Non Sway
2ND to 3RD	EQX	3.1	14729.841	3.521	1002.528	0.017	Non Sway
3RD to TERRACE	EQX	2.9	8456.925	3.107	728.648	0.012	Non Sway
TERRACE to OHT	EQX	3	1855.691	4.021	269.452	0.009	Non Sway
OHT to OHTTOP	EQX	1.9	642.217	2.297	92.177	0.008	Non Sway

For Global-Y Direction

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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)	
Base to STILT	EQY	3	29815.655	0.279	1386.404	0.002	Non Sway
STILT to 1ST	EQY	3.5	28500.823	0.81	1386.404	0.005	Non Sway
1ST to 2ND	EQY	3.3	21636.497	3.707	1345.407	0.018	Non Sway
2ND to 3RD	EQY	3.1	14729.841	3.42	1188.093	0.014	Non Sway
3RD to TERRACE	EQY	2.9	8456.925	2.756	863.518	0.009	Non Sway
TERRACE to OHT	EQY	3	1855.691	2.398	319.328	0.005	Non Sway
OHT to OHTTOP	EQY	1.9	642.217	1.226	109.239	0.004	Non Sway

General Data

Column No.	:	C24	
Level	:	Base To STILT	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	2250	mm
Clear Floor Height @ D	=	2400	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.	=	C24	
Critical Analysis Load Combination	=	1.5 DL + 1.5 EQY	
Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Critical Location	=	Bottom Joint	
Pu	=	2682.76	kN
Mux	=	18.66	kNm
Muy	=	222.85	kNm
Vux	=	93.61	kN
Vuy	=	-12.07	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	455.368	No Beam	No Beam	-	-	1
Top	455.368	11755.72 x 230 x 600	No Beam	44.546	-	0.95

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

Calculation Along Minor Axis Of Column

Joint		Beam Sizes	Beam Stiffness	Beta

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	Column Stiffness	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	455.368	No Beam	No Beam	-	-	1
Top	455.368	4650 x 230 x 750	No Beam	219.957	-	0.793

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	
	=	24.8	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	66.53	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	3.75	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / D
	=	4.8, Column not Slender Along D

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Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / B
	=	4.5, 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	18.66	66.53	66.53	0	66.53
Minor Axis - Muy	222.85	---	222.85	0	222.85

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	=	2682.76	kN
Mux	=	66.53	kNm
Muy	=	222.85	kNm

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Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.89	
Reinforcement Provided	=	16-T16	
Load Angle	=	Tan-1(Muy/Mux)	
	=	73.38	deg
MRes	=	232.57	kNm
MCap	=	652.09	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.36 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	0.9 DL - 1.5 EQX	
Critical Load Combination	=	[3] : 0.9 (Dead) +0.9 (Wall) -1.5 (EQX)	
Design shear force, Vuy	=	-46.4203	kN
Pu	=	1396.67	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.1402	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.291	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.291	

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Enhanced shear strength, Tv e	=	0.6574	N/sq.mm
Design shear check	=	Tvx < Tv e Enhancement factor	

Link for Shear Design along D are not required

Design for shear along B

Critical Analysis Load Combination	:	0.9 DL + 1.5 EQX	
Critical Load Combination	=	[10] : 0.9 (Dead) +0.9 (Wall) + 1.5 (EQX)	
Design shear force, Vux	=	82.8189	kN
Pu	=	1710.84	
Bdl	=	997	mm
Design shear stress, Tvx	=	Vux / (B x Bdl)	kN
	=	0.2501	N/sq.mm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sq.mm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2581	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2581	
Enhanced shear strength, Tv e	=	0.6574	N/sq.mm
Design shear check	=	Tvx < Tv e 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

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	= 4	mm
Criterion for spacing of normal links		
Min. Longitudinal Bar dia X 16	= 256	mm
Min. dimension of column	= 600	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 300	
Provided spacing	= 250	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	250	---	---	250	---

General Data

Column No.	:	C24	
Level	:	STILT To 1ST	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	2900	mm
Clear Floor Height @ D	=	3050	mm

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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.	=	C24	
Critical Analysis Load Combination	:	1.5 DL + 1.5 EQY	
Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Critical Location	=	Bottom Joint	
Pu	=	2360.07	kN
Mux	=	-4.72	kNm
Muy	=	213.12	kNm
Vux	=	96.41	kN
Vuy	=	-21.22	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	390.315	11755.72 x 230 x 600	No Beam	44.546	-	0.95
Top	390.315	11747.21 x 600 x 450	No Beam	49.061	-	0.943

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	390.315	4650 x 230 x 750	No Beam	219.957	-	0.793
Top	390.315	4650 x 230 x 600	No Beam	112.618	-	0.877

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	
	=	26.1	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	61.6	kNm

Slenderness Check

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

Column Is Unbraced Along D

Slenderness Check Along D:

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Effective Length Factor = 1.2

Slenderness Ratio = Effective Length / D

= 6.1, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor = 1.2

Slenderness Ratio = Effective Length / B

= 5.8, 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	-4.72	61.6	-61.6	0	-61.6
Minor Axis - Muy	213.12	---	213.12	0	213.12

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	=	2360.07	kN
Mux	=	-61.6	kNm
Muy	=	213.12	kNm

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Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.89	
Reinforcement Provided	=	16-T16	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	73.88	deg
MRes	=	221.85	kNm
MCap	=	648.94	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.34 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	0.9 DL - 1.5 EQX	
Critical Load Combination	=	[3] : 0.9 (Dead) +0.9 (Wall) -1.5 (EQX)	
Design shear force, Vuy	=	-44.746	kN
Pu	=	1237.88	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.1351	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2579	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2579	
Enhanced shear strength, Tc-e	=	0.6089	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

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Design for shear along B

Critical Analysis Load Combination	:	0.9 DL + 1.5 EQY	
Critical Load Combination	=	[18] : 0.9 (Dead) +0.9 (Wall) +1.5 (EQY)	
Design shear force, Vux	=	84.0382	kN
Pu	=	1495.95	
Beff	=	552	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.2537	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.3117	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.3117	
Enhanced shear strength, Tc-e	=	0.6349	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	=	256	mm
Min. dimension of column	=	600	mm

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Max. 300 mm = 300 mm

Least lateral edge dimension/2 = 300

Provided spacing = 250 mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	—	—	8	—
Spacing	250	—	—	250	—

General Data

Column No.	:	C24	
Level	:	1ST To 2ND	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	2700	mm
Clear Floor Height @ D	=	2850	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.	=	C24
Critical Analysis Load Combination	:	1.2 DL + 1.2 LL - 1.2 EQX

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Load Combination	=	[31] : 1.2 (Dead) +1.2 (Wall) +1.2 (Live) -1.2 (EQX) +1.2 (Terrace Live)	
Critical Location	=	Bottom Joint	
Pu	=	1588.57	kN
Mux	=	-200.62	kNm
Muy	=	87.3	kNm
Vux	=	49.68	kN
Vuy	=	-106.53	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	413.971	11747.21 x 600 x 450	No Beam	49.061	-	0.943
Top	413.971	11747.21 x 600 x 450	No Beam	49.061	-	0.946

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	

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Bottom	413.971	4650 x 230 x 600	No Beam	112.618	-	0.877
Top	413.971	4650 x 230 x 600	No Beam	112.618	-	0.884

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	
	=	25.7	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	40.83	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	4.5	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / D
	=	5.7, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / B

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= 5.4, 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	-200.62	40.83	-200.62	0	-200.62
Minor Axis - Muy	87.3	---	87.3	0	87.3

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	=	1588.57	kN
Mux	=	-200.62	kNm
Muy	=	87.3	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.89	
Reinforcement Provided	=	16-T16	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	23.52	deg

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MRes	=	218.8	kNm
MCap	=	586.88	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.37 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	0.9 DL - 1.5 EQX	
Critical Load Combination	=	[3] : 0.9 (Dead) +0.9 (Wall) -1.5 (EQX)	
Design shear force, Vuy	=	-92.452	kN
Pu	=	1004.9	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.2791	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2094	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2094	
Enhanced shear strength, Tc-e	=	0.5854	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	:	0.9 DL + 1.5 EQY	
Critical Load Combination	=	[18] : 0.9 (Dead) +0.9 (Wall) +1.5 (EQY)	
Design shear force, Vux	=	106.611	kN
Pu	=	1234.05	

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Beff	=	552	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.3219	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2571	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2571	
Enhanced shear strength, Tc-e	=	0.6085	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	=	256	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Least lateral edge dimension/2	=	300	
Provided spacing	=	250	mm

Table For Links

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	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	250	---	---	250	---

General Data

Column No.	:	C24	
Level	:	2ND To 3RD	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	2500	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.	=	C24	
Critical Analysis Load Combination	:	1.2 DL + 1.2 LL - 1.2 EQX	
Load Combination	=	[31] : 1.2 (Dead) +1.2 (Wall) +1.2 (Live) -1.2 (EQX) +1.2 (Terrace Live)	
Critical Location	=	Bottom Joint	
Pu	=	1189.75	kN

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Mux	=	-164.42	kNm
Muy	=	93.63	kNm
Vux	=	58.35	kN
Vuy	=	-103.78	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	440.679	11747.21 x 600 x 450	No Beam	49.061	-	0.946
Top	440.679	11747.21 x 600 x 450	No Beam	49.061	-	0.949

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	440.679	4650 x 230 x 600	No Beam	112.618	-	0.884
Top	440.679	4650 x 230 x 600	No Beam	112.618	-	0.89

Sway Condition (as per Stability Index) = Non Sway

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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	
	=	30.1	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	4.17	
	<	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
	=	5, Column not Slender Along B

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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	-164.42	30.1	-164.42	0	-164.42
Minor Axis - Muy	93.63	---	93.63	0	93.63

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	=	1189.75	kN
Mux	=	-164.42	kNm
Muy	=	93.63	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.89
Reinforcement Provided	=	16-T16

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Load Angle	=	Tan-1(Muy/Mux)	
	=	29.66	deg
MRes	=	189.21	kNm
MCap	=	540.94	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.35 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	0.9 DL - 1.5 EQX	
Critical Load Combination	=	[3] : 0.9 (Dead) +0.9 (Wall) -1.5 (EQX)	
Design shear force, Vuy	=	-95.9661	kN
Pu	=	753.92	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.2898	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.1571	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.1571	
Enhanced shear strength, Tc-e	=	0.5601	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	:	1.5 DL + 1.5 EQY
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)

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Design shear force, Vux	=	133.525	kN
Pu	=	1503.5	
Beff	=	552	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.4032	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.3132	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.3132	
Enhanced shear strength, Tc-e	=	0.6356	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	=	256	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Least lateral edge dimension/2	=	300	
Provided spacing	=	250	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	250	---	---	250	---

General Data

Column No.	:	C24	
Level	:	3RD To TERRACE	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	2300	mm
Clear Floor Height @ D	=	2450	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.	=	C24	
Critical Analysis Load Combination	:	1.5 DL -1.5 EQY	
Load Combination	=	[1] : 1.5 (Dead) +1.5 (Wall) - 1.5 (EQY) +1.5 (Terrace Live)	
Critical Location	=	Top Joint	
Pu	=	789.21	kN

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Mux	=	215.02	kNm
Muy	=	-17.11	kNm
Vux	=	29.52	kN
Vuy	=	-160.04	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	471.07	11747.21 x 600 x 450	No Beam	49.061	-	0.949
Top	471.07	11747.21 x 600 x 450	No Beam	49.061	-	0.95

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	471.07	4650 x 230 x 600	No Beam	112.618	-	0.89
Top	471.07	4650 x 230 x 600	No Beam	112.618	-	0.892

Sway Condition (as per Stability Index) = Non Sway

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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	
	=	24.6	mm
Minimum Eccentricity	>	20	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	19.41	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	3.83	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / D
	=	4.9, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / B
	=	4.6, Column not Slender Along B

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Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	215.02	---	215.02	0	215.02
Minor Axis - Muy	-17.11	19.41	-19.41	0	-19.41

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	=	789.21	kN
Mux	=	215.02	kNm
Muy	=	-19.41	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.89	
Reinforcement Provided	=	16-T16	

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Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	5.16	deg
MRes	=	215.9	kNm
MCap	=	514.98	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.42 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	1.5 DL -1.5 EQY	
Critical Load Combination	=	[1] : 1.5 (Dead) +1.5 (Wall) -1.5 (EQY) +1.5 (Terrace Live)	
Design shear force, Vuy	=	-160.0405	kN
Pu	=	789.21	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.4832	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.1644	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.1644	
Enhanced shear strength, Tc-e	=	0.5636	N/sqmm
Design shear check	=	Tvy < Tc x Enhancement factor	

Link for Shear Design along D are not required

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Design for shear along B

Critical Analysis Load Combination	:	1.5 DL + 1.5 EQY	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Design shear force, Vux	=	128.3484	kN
Pu	=	1087.09	
Beff	=	552	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.3875	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.2265	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.2265	
Enhanced shear strength, Tc-e	=	0.5936	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	=	256	mm
Min. dimension of column	=	600	mm

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Max. 300 mm

Least lateral edge dimension/2 = 300 mm

= 300

Provided spacing = 250 mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	250	---	---	250	---

General Data

Column No.	:	C24	
Level	:	TERRACE To OHT	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	2400	mm
Clear Floor Height @ D	=	3000	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.	=	C24	
Critical Analysis Load Combination	=	1.5 DL - 1.5 EQX	
Load Combination	=	[38] : 1.5 (Dead) +1.5 (Wall) - 1.5 (EQX) +1.5 (Terrace Live)	
Critical Location	=	Bottom Joint	
Pu	=	489.4	kN
Mux	=	-199	kNm
Muy	=	110.77	kNm
Vux	=	73.52	kN
Vuy	=	-89.21	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	455.368	11747.21 x 600 x 450	No Beam	49.061	-	0.85
Top	455.368	No Beam	No Beam	-	-	1

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	

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	N/m	mm	mm	N/m	N/m	
Bottom	455.368	4650 x 230 x 600	No Beam	112.618	-	0.892
Top	455.368	4650 x 230 x 600	No Beam	112.618	-	0.913

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	
	=	26	mm
Minimum Eccentricity	>	20	mm
Mminx	=	Pu x Minimum Eccentricity	
	=	12.72	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	4	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1.2
Slenderness Ratio	=	Effective Length / D
	=	6, 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
	=	4.8, 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	-199	12.72	-199	0	-199
Minor Axis - Muy	110.77	---	110.77	0	110.77

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	=	489.4	kN
Mux	=	-199	kNm
Muy	=	110.77	kNm

Resultant Moment (Combined Action)

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Moment Capacity Check

Pt Calculated	=	0.89	
Reinforcement Provided	=	16-T16	
Load Angle	=	Tan-1(Muy/Mux)	
	=	29.1	deg
MRes	=	227.76	kNm
MCap	=	450.35	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.51 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	0.9 DL + 1.5 EQX	
Critical Load Combination	=	[21] : 0.9 (Dead) +0.9 (Wall) +1.5 (EQX)	
Design shear force, Vuy	=	101.7455	kN
Pu	=	399.94	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.3072	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0833	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0833	
Enhanced shear strength, Tc-e	=	0.5244	N/sqmm

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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	:	1.5 DL + 1.5 EQY	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Design shear force, Vux	=	130.5002	kN
Pu	=	640.85	
Beff	=	552	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.394	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.1335	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.1335	
Enhanced shear strength, Tc-e	=	0.5486	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

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Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	= 256	mm
Min. dimension of column	= 600	mm
Max. 300 mm	= 300	mm
Least lateral edge dimension/2	= 300	
Provided spacing	= 250	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	250	---	---	250	---

General Data

Column No.	:	C24	
Level	:	OHT To OHTTOP	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	N/sqmm
Grade Of Steel	=	Fe500	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Floor Height @ B	=	1300	mm
Clear Floor Height @ D	=	1900	mm
No Of Floors	=	1	

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No Of Columns In Group	=	1
Column Type	:	UnBraced
Minimum eccentricity check	:	One Axis at a Time

Load Data

Analysis Reference No.	=	C24	
Critical Analysis Load Combination	:	1.5 DL + 1.5 EQY	
Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Critical Location	=	Bottom Joint	
Pu	=	255.06	kN
Mux	=	52.85	kNm
Muy	=	194.6	kNm
Vux	=	249.66	kN
Vuy	=	57.82	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	719.002	No Beam	No Beam	-	-	1
Top	719.002	No Beam	No Beam	-	-	1

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	719.002	4650 x 230 x 600	No Beam	112.618	-	0.913
Top	719.002	4650 x 230 x 600	No Beam	112.618	-	0.865

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

= 23.8 mm

Minimum Eccentricity > 20 mm

Mminx = Pu x Minimum Eccentricity

= 6.07 kNm

Slenderness Check

Max Slenderness Ratio(L/B) = 2.17

< 60 (Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

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Effective Length Factor = 1.2

Slenderness Ratio = Effective Length / D

= 3.8, Column not Slender Along D

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor = 1.2

Slenderness Ratio = Effective Length / B

= 2.6, 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	52.85	6.07	52.85	0	52.85
Minor Axis - Muy	194.6	---	194.6	0	194.6

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	=	255.06	kN
Mux	=	52.85	kNm
Muy	=	194.6	kNm

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Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.89	
Reinforcement Provided	=	16-T16	
Load Angle	=	Tan-1(Muy/Mux)	
	=	74.81	deg
MRes	=	201.65	kNm
MCap	=	411.65	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.49 <= 1	

Design Of Shear

Design for shear along D

Critical Analysis Load Combination	:	1.5 DL + 1.5 EQY	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Design shear force, Vuy	=	57.8153	kN
Pu	=	237.51	
Deff	=	552	mm
Design shear stress, Tvy	=	Vuy / (Bx Deff)	N/sqmm
	=	0.1746	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0495	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0495	

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Enhanced shear strength, Tc-e	=	0.508	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	:	1.5 DL + 1.5 EQY	
Critical Load Combination	=	[24] : 1.5 (Dead) +1.5 (Wall) +1.5 (EQY) +1.5 (Terrace Live)	
Design shear force, Vux	=	249.6606	kN
Pu	=	237.51	
Beff	=	552	mm
Design shear stress, Tvx	=	Vux / (D x Beff)	kN
	=	0.7538	N/sqmm
Pt	=	0.447	%
Design shear strength, Tc	=	0.484	N/sqmm
Shear Strength Enhancement Factor	=	1 + 3 x Pu / (B x D x Fck)	
	=	1.0495	
Shear Strength Enhancement Factor (max)	=	1.5	
Shear Strength Enhancement Factor	=	1.0495	
Enhanced shear strength, Tc-e	=	0.508	N/sqmm
Design shear check	=	Tvx > Tc x Enhancement factor	

Links for shear design along B

Pt	=	0.4468	%
Beff	=	552	mm
Shear resisted by concrete along B = VcB	=	(Tc-e) x (Beff x D)	
	=	168.24	kN

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	=	0.4468	%
Beff	=	552	mm
Shear resisted by concrete along B = VcB	=	(Tc-e) x (Beff x D)	
	=	168.24	kN
Shear to be resisted by shear reinforcement along B = VusB	=	Vuy - VcB	
	=	81.42	kN
Area of shear reinforcement required, Asv-B	=	(VusB x 1000)/ (Beff x 0.87 x Fy)	
	=	408.52	sqmm
Master Link Rebar	=	8	mm
Number of legs provided	=	6	
Spacing of links reqd	=	738	mm
Spacing of links prvd, Sv	=	250	mm
Asv Provided	=	1206.37	sqmm

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	=	256	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Least lateral edge dimension/2	=	300	

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rovided spacing = 250 mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	250	---	---	250	---

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SLAB DESIGN CALCULATIONS

Project Name	:	ARCOT ROAD
Client Name	:	Mr.HEMANTH RAJ
Engineer Name	:	NSS
Design File	:	E:\SANDHYA\ARCOT ROAD\SLAB

NOTES:

1. Slab is designed as per 1 M width of panel.
2. Density of concrete assumed as 40 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)

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.	ε1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
5.	pact	=	Percentage steel provided
6.	pcrit	=	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
22.	Vu	=	Factored shear force in kN
23.	Wcr	=	Surface Crack Width

Code References :

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	ELEMENT		CLAUSE / TABLE
1.	Moment Coeffs For 2-Way Slabs	:	Grashoff-Rankine Formulation and yield line theory
2.	Pmin	:	26.5.2.1
3.	Pt calculated	:	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

Slab No. :	**S1**		
Level	=	7m	
Design Code	=	IS Code	
Grade Of Concrete	=	M40	
Grade Of Steel	=	Fe500	
Clear Cover	=	25.000	mm
Long Span, Ly	=	3.940	m
Short Span, Lx	=	3.000	m
Imposed Load	=	1.200	kN/sqm
Live Load	=	2.000	kN/sqm
Slab Thickness	=	150.000	mm
Effective Depth Along LX, Deffx	=	95.000	mm
Effective Depth Along LY, Deffy	=	85.000	mm
Self Weight	=	3.750	kN/sqm
Total Load, TL	=	6.950	kN/sqm
Span	=	2-Way	
Panel Type	=	Interior Panel	
Load Combination	=	1.5 DL + 1.5 LL	

Design Moments:

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Short Span Positive Moment At Midspan -

Moment Coefficient	=	0.066	
BM	=	0.868	kNm
Mu = 1.5 X BM	=	1.303	kNm
Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 150 C/C	
	=	286.000	sqmm/m

Short Span Negative Moment At Continuous Support -

Moment Coefficient	=	0.088	
BM	=	0.868	kNm
Mu = 1.5 X BM	=	1.303	kNm
Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 150 C/C	
	=	286.000	sqmm/m

Long Span Positive Moment At Midspan -

Moment Coefficient	=	0.034	
BM	=	0.709	kNm
Mu = 1.5 X BM	=	1.185	kNm
Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 175 C/C	
	=	286.000	sqmm/m

Long Span Negative Moment At Continuous Support -

Moment Coefficient	=	0.045	
BM	=	0.709	kNm
Mu = 1.5 X BM	=	1.185	kNm
Area Of Reinforcement Required (Mu)	=	150.000	sqmm/m
Reinforcement Provided	=	T10 @ 175 C/C	
	=	286.000	sqmm/m

Distribution Reinforcement @ 0.12% -

Area Of Reinforcement Required	=	180.000	sqmm/m
Reinforcement Provided	=	T10 @ 175 C/C	
	=	286.000	sqmm/m

Shear Check :

Along Short Span

Shear Coefficient(Lx), SF1	=	0.576	
V = SF1 x TL x Lx	=	8.057	kN
Vu = 1.5 X V	=	12.085	kN
Shear Stress, Tv	=	0.127	N/sqmm
Nominal Shear Stress, Tc	=	0.294	N/sqmm
Modification Factor 'K'	=	1.300	
K x Tc	=	0.382	

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	>	0.127	Slab Is Safe In Shear

Along Long Span

Shear Coefficient(Ly), SF2	=	0.400	
V = SF2 x TL x Lx	=	5.595	kN
Vu = 1.5 X V	=	8.393	kN
Shear Stress, Tv	=	0.099	N/sqmm
Nominal Shear Stress, Tc	=	0.294	N/sqmm
Modification Factor 'K'	=	1.300	
K x Tc	=	0.382	
	>	0.099	Slab Is Safe In Shear

Deflection Check:

Basic Span To Depth Ratio	=	18.40	
Span Correction Factor	=	1.000	
Tensile Steel Factor	=	2.569	
Compression Steel Factor	=	1.000	
Flange Correction Factor	=	1.000	
Max Span To Depth Ratio	=	18.40 x 1.00 x 2.57 x 1.00 x 1.00	
	=	47.288	
Lx/d	=	15.789	
	<	66.801	Slab Is Safe In Deflection

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BEAM DESIGN CALCULATION

Project Name	:	ARCOT ROAD
Client Name	:	Mr.HEMANTHRAJ
Engineer Name	:	NSS
Design File	:	B:\SANDHYA\ARCOT ROAD\RCDC\2nd floor beam (07.11.23).rcdx
Analysis File	:	B:\SANDHYA\ARCOT ROAD\MDB\Arcot_road new.mdb
Analysis Last Modified	:	07-11-2023 09:28:30
Level Designed	:	2ND

Sr.No.	Symbol		Definitions
1	a	=	Angle formed with horizontal by diagonal reinforcement
2	e1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
3	em	=	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
20	d'	=	Clear cover to reinforcement at compression side.

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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
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 induced shear in kN

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64	Vu design	=	Max of (Vu-A1 and Vu-A2) & (Vu-B1 and Vu-B2) in kN
65	Vud	=	Vud : Vu Design Shear Force for reinforcement in kN
66	V_{tu}	=	Total Shear Force = Vu + V_{tu} in kN
67	Wcr	=	Converted Shear Force due to Torsion at a section in kN
68	WcrDesm	=	Surface Crack Width
69	Xl	=	Permissible Crack Width required in mm
70	Yl	=	Smaller c/c dimension of outermost Stirrups
		=	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

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Sr.No.	Item	Clause / Table
1.	Ptmax	: 26.5.1.1
2.	Ptmin	: 26.5.1.1
3.	M_{1u}	: 41.4.2
4.	V_{1u}	: 41.3.1
5.	Pitch	: 38
6.	Tc	: 40.2.1
7.	Tcmax	: 40.2.3
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.	Svch	: 6.3.5

Group	: G3		
Beam No	: B4		
Analysis Reference (Member)	2ND : B26		
Beam Length	: 3000	mm	
Breadth (B)	: 230	mm	
Depth (D)	: 600	mm	

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Effective Depth (d)	: 545	mm
Design Code	: IS 456	
Beam Type	: Regular Beam	
Grade Of Concrete (Fck)	: M40	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	1.2 DL + 1.2 LL + 1.2 EQY	1.5 DL + 1.5 EQY	1.5 DL - 1.5 EQX	1.5 DL -1.5 EQY	1.2 DL + 1.2 LL - 1.2 EQY	1.2 DL + 1.2 LL + 1.2 EQX
Critical L/C - RCDC	16	24	38	1	27	13
Mu (kNm)	26.244	29.988	3.68	0.518	8.336	59.125
Tu (kNm)	0.657	0.25	8.4	17.546	10.403	7.76
M_{Tu} (kNm)	1.39	0.53	17.84	37.25	22.08	16.47
Mud (kNm)	27.64	30.52	21.52	37.76	30.42	75.6
MuLim (kNm)	364	364	364	364	364	364
R	0.405	0.447	0.315	0.553	0.445	1.107
Ptmin (%)	0.3	0.3	0.3	0.3	0.3	0.3
Ptclc (%)	0.3	0.3	0.3	0.3	0.3	0.3
Pcclc (%)	0	0	0.048	0.126	0.047	0
PtPrv (%)	0.321	0.321	0.321	0.321	0.321	0.321
AstCalc (sqmm)	376.05	376.05	376.05	376.05	376.05	376.05
AstPrv (sqmm)	402.12	402.12	402.12	402.12	402.12	402.12
Reinforcement	2-T16	2-T16	2-T16	2-T16	2-T16	2-T16

Shear Design

	Left	Mid	Right
Critical L/C - Analysis	1.5 DL - 1.5 EQX	1.5 DL - 1.5 EQX	1.5 DL + 1.5 LL
Critical L/C - RCDC	38	38	2
PtPrv (%)	0.321	0.321	0.321
Vu (kN)	19.856	7.593	69.347
Tu (kNm)	8.522	8.522	12.518
V_{Tu} (kN)	59.28	59.28	87.08
Vut (kN)	79.14	66.87	156.43
Tv (N/sqmm)	0.63	0.53	1.25

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Tc (N/sqmm)	0.42	0.42	0.42
Vc (kN)	52.5	52.5	52.5
Vus=Vut-Vc (kN)	26.64	14.37	103.93
Legs	2	2	2
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	310.699	285.257	539.774
Asv Torsion Prv (sqmm)	574.51	574.51	574.51
Asv Reqd (sqmm)	254.812	254.812	528.163
SvCalc (mm)	175	175	175
SvPrv (mm)	175	175	175
Asv Total Prv (sqmm)	574.51	574.51	574.51

Maximum Spacing Criteria

Basic

Spc1 =0.75d = 409 mm

Spc2 = 300 mm

For Torsion

(X1 = 190, Y1 = 560)

Spc3 = X1 = 190 mm

Spc4=(X1+Y1)/4 = 175 mm

SFR Design

Beam Width = 230 mm

Beam Depth = 600 mm

Torsion = 12.52 > 0 kNm

Beam Depth >750 Or Torsion > 0,
Hence SFR Provided

= 138 sqmm

SFR Provided = 2-T8EF

ASFR Provided = 201.08 sqmm

Spacing Criteria

Provided Spacing = 172.67 mm

1.<= beam Width = 230 mm

2. Not Greater Than = 300 mm

S.Skumaran

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