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STRUCTURAL STABILITY CERTIFICATE

Name of work : Plan Showing the Proposed Construction of Multi Storeyed Building in Town Survey No.22/5, 23/4, 24/4, 25/2, 29/2, 30/1, 30/4, 31/2, 32/2, 33/2 & 34/2, Block No.2, Alandur Village, Guindy Taluk (Previously Mambalam-Guindy Taluk), Corporation of Chennai.

Preamble

: 1. I hereby certify that the structural design sheet is done for Column, Foundation, Slab and beam.

2. The building consists of blocks (A,E,F) 2 combined Basements + Stilt floor +14 upper floors, club house (G+7 floors) and MLCP (2 combined Basements + Stilt floor +7 floors).

3. The usage of the building is 2 Basements + Stilt floor +14 upper floors.

4. The Super Structure is built on 200mm thick outer wall &100mm thick inner walls.

5. The soil is clay mixed sand.

6. All concrete for RCC members in 2 combined Basements + Stilt floor +14 upper floors are M35 & M40 concrete.

7. The structural design includes the earth quake Criteria as per IS: 1893(part 1)-latest revision.

STRUCUTURAL SYSTEM

The structural system adopted is as below, based on preliminary analysis and design, which have been elucidated later in this report.

- The building is basically a RC framed structure comprising of 2 combined Basements + Stilt floor +14 upper floors. The analysis and design are done using STAAD Pro Software.
- The foundation system Comprised of Isolated foundation is adopted as per Soil Test Report.
- All slabs are designed as conventional slabs.
- The building is designed on the basis of "Earthquake resistant design of Structures IS 1893 (Part 1): 2002 General provisions & Buildings with declaration of Seismic Zone III.
- **The above structure is structurally sound and safe.**

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This is to certify that the Structural Design of the proposed residential building at above said site has been DESIGNED on the basis of EARTHQUAKE RESISTANT DESIGN OF STRUCTURES IS 1893 (Part 1): 2002 General Provisions & Buildings, with latest declaration of Seismic Zone III, Zone factor 0.16 and according to I.S. Loading standards I.S. – 875 All precautions have been taken as per the CONTENTS OF REPORT FOUNDATION ANALYSIS.. This Report has recommendations for effect of Seismic Condition for this Soil.

CALCULATION OF SEISMIC CO-EFFICIENT:

Name of city	: Chennai
Type of Building	: Residential Building
Building Frame System	: Special RC-Moment resisting frame (SMRF)
Fundamental Natural Period (Ts)	: (0.075)h ^3/4 =1.30 sec.
Soil conditions	: medium
Zone Factor (Refer Table:2) (Z)	: 0.16 (moderate)
Importance Factor (Refer Table:6) (I)	: 1.0
Response Reduction (Refer Table:7)	: 5.0
Average response acceleration Co-efficient (Sa/g)	: 1.04

EARTH QUAKE ANALYSIS:

Horizontal Seismic Co-efficient (Ah)	= (Z/2)(I / R)(Sa/g) =(0.16/2) (1.0/5.0) (1.04) = 0.016
Design value of Ah	= 0.016
Type of Foundation	: Raft Foundation

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1. GENERAL LOADING CONDITIONS:

(a) Imposed loads on Roof - 1.50kN/m^2

(b) Imposed loads on Hall, Kitchen. & Bed

Residential - 2.00kN/m^2

(d) Dead weight of R.C.C - 25kN/m^3

(e) Dead weight of Brick Work - 20kN/m^3

2. LOADING ON SLABS:

2.1 Loading on Roof slab:

Roof finished with lime concrete terracing	=(0.10)(20) =2.000kN/m^2
S/W of slab 125mm thick	=(.125)(25) =3.125kN/m^2
Dead load	=5.125kN/m^2
Live load	=1.50kN/m^2
Total load on Roof	= 6.625kN/m^2

2.2 Loading on Floor slabs:

Floor finish	= 1.00kN/m^2
S/w of slab 125mm thick	= 3.125kN/m^2
Dead load	=4.125kN/m^2
Live load	=2.00kN/m^2
Total load on Roof	= 6.125kN/m^2

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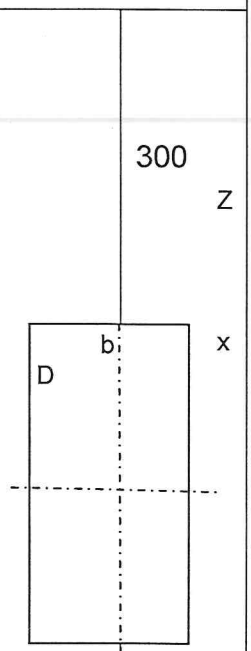
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3 DESIGN CALCULATIONS:

a. column design - C1:

COLUMN DESIGN- VGN

Member no			Load Case	
Grade of Concrete			M 35	
Characteristic Strength of Reinf.		N/mm^2	500	
Width of Column	b	mm	300	
Depth of Column	D	mm	1500	
Unsupported Length of Column	l_x	mm	3000	
Unsupported Length of Column	l_y	mm	3000	
Clear Cover to Reinf.		mm	40	
Diameter of Bar		mm	25	
Load		T		
Moment	M_{xx}	T.m		
Moment	M_{zz}	T.m		
Factored Load	P_u	kN	4894.956	1
Factored Moment	M_{ux}	kN.m	926.247	1
Factored Moment	M_{uz}	kN.m	491.757	1
Effective Length of Column	l_{ex}	mm	3600	1.2
	l_{ez}	mm	3600	1.2
	l_{ex}/D		2.4	0
			<12- Short Column	
	l_{ey}/b		12	0
			<12- Short Column	
Additional Moment due to Slender	M_{ax}	kN.m	0	
Additional Moment due to Slender	M_{az}	kN.m	0	
Percentage of Reinf.	p	%	2.6	
Gross Area of Cross Section	A_g	mm^2	450000	



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Ultimate Axial Load	P_{uz}	kN	11290.725	
d'/D (about x-x axis)			0.035	
d'/D (about y-y axis)			0.175	
(Table 60)	k1		0.219	
	k2		0.424	
	P_{bx}	kN	3945.330	
	k1		0.184	
	k2		0.028	
	P_{bz}	kN	2930.760	
	k_x		0.871	
	k_y		0.765	
Minimum Eccentricity	e_x	mm	56	
	e_y	mm	16	
Moments due to min. eccentricity	M_{ex}	kN.m	274.12 < 926.247	kN.m
Moments due to min. eccentricity	M_{ez}	kN.m	78.32 < 491.757	kN.m

Total Moments for which the column is to be designed are

	M_{ux}	kN.m	926.247	
	M_{uz}	kN.m	491.757	

The section is to be checked for biaxial bending

	$P_u/f_{ck}bD$		0.311	
	p/f_{ck}		0.0742857	
Referring to Chart 43 (d'/D is0.035)	$M_u/f_{ck}bD^2$		0.171	
	M_{ux1}	kN.m	4039.875	
Referring to Chart 46 (d'/D = 0.175)	$M_u/f_{ck}bD^2$		0.123	
	M_{uy1}	kN.m	581.175	
	M_{ux}/M_{ux1}		0.229	
	M_{uy}/M_{uy1}		0.846	
	P_u/P_{uz}		0.434	

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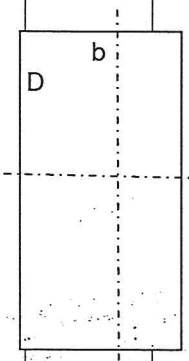
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		a	1 1.39	
			< 1	
Mux/Mux1 + Muy/Muy1			0.922 OK	
Area of Reinforcement	As	mm^2	11700	
Minimum no of to be provided			12	
No of Bars to be provided	Nos.		24	

b. column design – C2

COLUMN DESIGN- VGN

Member no			Load Case	
Grade of Concrete			M 35	
Characteristic Strength of Reinf.		N/mm^2	500	300
Width of Column	b	mm	300	Z
Depth of Column	D	mm	1500	
Unsupported Length of Column	l_x	mm	3300	
Unsupported Length of Column	l_y	mm	3300	x
Clear Cover to Reinf.		mm	30	
Diameter of Bar		mm	25	
Load		T		
Moment	M_{xx}	T.m		
Moment	M_{zz}	T.m		
Factored Load	P_u	kN	6041.331	1
Factored Moment	M_{ux}	kN.m	454.932	1
Factored Moment	M_{uz}	kN.m	207.909	1
Effective Length of Column	l_{ex}	mm	3960	1.2
	l_{ez}	mm	3960	1.2
	l_{ex}/D		2.64	0
			<12- Short Column	



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	l_{ey}/b		13.2	1
			>12- Slender Column	
Additional Moment due to Slender	M_{ax}	kN.m	0	
Additional Moment due to Slender	M_{az}	kN.m	157.89623	
Percentage of Reinf.	p	%	2	
Gross Area of Cross Section	A_g	mm^2	450000	
Ultimate Axial Load	P_{uz}	kN	10320.75	
d'/D (about x-x axis)			0.035	
d'/D (about y-y axis)			0.175	
(Table 60)	k1		0.219	
	k2		0.424	
	P_{bx}	kN	3830.850	
	k1		0.184	
	k2		0.028	
	P_{bz}	kN	2923.200	
	k_x		0.659	
	k_y		0.578	
Minimum Eccentricity	e_x	mm	56.6	
	e_y	mm	16.6	
Moments due to min. eccentricity	M_{ex}	kN.m	341.94 < 454.932	kN.m
Moments due to min. eccentricity	M_{ez}	kN.m	100.29 < 207.909	kN.m
Total Moments for which the column is to be designed are				
	M_{ux}	kN.m	454.932	
	M_{uz}	kN.m	299.251	
The section is to be checked for biaxial bending				
	$P_u/f_{ck}bD$		0.384	
	p/f_{ck}		0.0571429	
Referring to Chart 43 (d'/D is0.035)	$M_u/f_{ck}bD^2$		0.112	

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	M_{ux1}	kN.m	2646.000	
Referring to Chart 46 (d'/D = 0.175)	$M_u/f_{ck}bD^2$		0.088	
	M_{uy1}	kN.m	415.800	
	M_{ux}/M_{ux1}		0.172	
	M_{uy}/M_{uy1}		0.720	
	P_u/P_{uz}		0.586	
		a	1	1.6433
Mux/Mux1 + Muy/Muy1			0.638	< 1 OK
Area of Reinforcement	As	mm^2	9000	
Minimum no of to be provided			12	
No of Bars to be provided	Nos.		19	

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3.2 RAFT BEAM DESIGN

a. raft beam design – RB1

Beam Data

width	2000 mm
depth	1100 mm
clear cover to main reinf.	30 mm
Slab Thickness	400 mm

d' 51 mm
eff depth 1050 mm

Material Grades

Concrete	40 MPa
Steel	500 MPa

				Span Moment
Span Moment	0 KN-m		Mu/bd^2	0.00
			xumax	479
			Mulim	11722
Support Moment	3349 KN-m	3319 KN-m	$Mulim/bd^2$	5.32
		33 KN-m		

Span Reinforcement

Beam is designed as Singly Reinforced Beam
Minimum % of Steel as per IS 456 clause 25.5 required

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.170 %	------
Area of Steel	3568 sqmm	

Refer Table 2 SP 16 pg 48

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	5	2454 sqmm
Layer 2	20 mm	5	1571 sqmm
Layer 3	20 mm	0	0 sqmm
		Total Steel Provided	4025 sqmm

0.192 %

Provided Steel OK

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Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	4	
Layer 2	25 mm	0	
Layer 3			
Total Steel Provided			#VALUE!

Support Reinforcement
Beam is designed as Singly Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)	
Percentage	0.366 %	------	*Refer Table 2 SP 16 pg 48*
Area of Steel	7689 sqmm		

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel	
Layer 1	25 mm	10	4909 sqmm	
Layer 2	20 mm	9	2827 sqmm	
Layer 3	20 mm	0	0 sqmm	
Total Steel Provided			7736 sqmm	0.369 %
Provided Steel OK				

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel	
Layer 1	16 mm	2		
Layer 2	25 mm	0		
Layer 3				
Total Steel Provided				#VALUE!

Shear Force (Vu)	1613 KN		
ζv	0.781	*=Vu / (b * d)*	
ζc	0.333	*Refer Table 61 SP 16 pg 179*	*or =(0.85*√(0.8*fck)*√(1+5β)-1)) / (6β)*
ζcmax	4	*Refer Table J SP 16 pg 175*	

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Type	Bar Dia	Nos	Area of Steel	
Layer 1	25 mm	0	0 sqmm	
Layer 2	25 mm	0	0 sqmm	
Layer 3	20 mm	0	0 sqmm	
			0 sqmm	0.000 %

Sectional Dimensions OK
Shear Reinforcements required

Steel	415 MPa	Vus/d	8.969 kN/cm
Type of stirrup	3 legged		
Stirrup diameter	10 mm		
Spacing	49 c/c	Safe	

b. raft beam design – RB2

Beam Data

width	1100 mm		
depth	1100 mm	d'	48 mm
clear cover to main reinf.	30 mm	eff depth	1052 mm
Slab Thickness	400 mm		

Material Grades

Concrete	40 MPa			
Steel	500 MPa			Span Moment
Span Moment	0 KN-m		Mu/bd²	0.00
			xumax	480
			Mulim	5889
Support Moment	2300 KN-m	2224 KN-m	Mulim/bd²	5.32
		62 KN-m		

Span Reinforcement

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Beam is designed as Singly
Reinforced Beam
Minimum % of Steel as per IS 456 clause 25.5
required

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.170 %	------
Area of Steel	1788 sqmm	

Refer Table 2 SP 16 pg 48

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	20 mm	0	0 sqmm
Layer 2	25 mm	4	1963 sqmm
Layer 3	20 mm	0	0 sqmm
	Total Steel Provided		1963 sqmm

0.187 %

Provided Steel OK

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	4	
Layer 2	25 mm	0	
Layer 3			
	Total Steel Provided		

#VALUE!

Support Reinforcement
Beam is designed as Singly
Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.511 %	------
Area of Steel	5371 sqmm	

Refer Table 2 SP 16 pg 48

Tension Reinforcement

Type	Bar dia	Nos	Area of

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			Steel	
Layer 1	25 mm	6	2945 sqmm	
Layer 2	25 mm	5	2454 sqmm	
Layer 3	20 mm	0	0 sqmm	
		Total Steel Provided	5400 sqmm	0.513 %

Provided Steel OK

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel	
Layer 1	16 mm	2		
Layer 2	25 mm	0		
Layer 3				
		Total Steel Provided		#VALUE!

Shear Force (Vu)	1676 KN		
ζv	1.688	*.=Vu / (b * d)*	
ζc	0.328	*Refer Table 61 SP 16 pg 179*	*or =(0.85*√(0.8*fck)*√(1+5β)-1)) / (6β)*
ζcmax	4	*Refer Table J SP 16 pg 175*	

Type	Bar Dia	Nos	Area of Steel	
Layer 1	25 mm	0	0 sqmm	
Layer 2	25 mm	0	0 sqmm	
Layer 3	20 mm	0	0 sqmm	
			0 sqmm	0.000 %

Sectional Dimensions OK
Shear Reinforcements required

Steel	415 MPa	Vus/d	13.591 kN/cm
Type of stirrup	3 legged		
Stirrup diameter	10 mm		
Spacing	32 c/c	Safe	

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3.3 BEAM DESIGN

a. beam design – B1

Beam Data

width	300 mm
depth	600 mm
clear cover to main reinf.	30 mm
Slab Thickness	125 mm

d' 48 mm .= cc+ sdia + mdia/2

eff depth 552 mm .= d - d'

Material Grades

Concrete	30 MPa
Steel	500 MPa

			Span Moment	Support Moment
Span Moment	264 KN-m	Mu/bd²	2.89	3.14
		xumax	252	252
		Mulim	365	365
Support Moment	287 KN-m	Mulim/bd²	3.99	3.99
	287 KN-m			
	0 KN-m			

Span Reinforcement

Beam is designed as
Singly Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.761 %	------
Area of Steel	1260 sqmm	

Refer Table 2 SP 16 pg 48

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	20 mm	0	0 sqmm
Layer 2	20 mm	3	942 sqmm
Layer 3	16 mm	2	402 sqmm
		Total Steel Provided	1345 sqmm

0.812 %

Provided Steel OK

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Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	16 mm	0	
Layer 2	25 mm	0	
Layer 3			
Total Steel Provided			

Support Reinforcement

Beam is designed as
Singly Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.840 %	------
Area of Steel	1391 sqmm	

Refer Table 2 SP 16 pg 48

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	0	0 sqmm
Layer 2	20 mm	3	942 sqmm
Layer 3	20 mm	2	628 sqmm
Total Steel Provided			1571 sqmm

0.949 %

Provided Steel OK

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	16 mm	0	
Layer 2	20 mm	0	
Layer 3			
Total Steel Provided			

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Shear Force (Vu)	**189 KN**		
ζv	1.141	*.=Vu / (b * d)*	
			or
			=(0.85√(0.8*fck)*√(1+5β)-1)) / (6β)*
ζc	0.605	*Refer Table 61 SP 16 pg 179*	
ζcmax	3.5	*Refer Table J SP 16 pg 175*	

Type	Bar Dia	Nos	Area of Steel
Layer 1	**25 mm**	**0**	0 sqmm
Layer 2	**25 mm**	**0**	0 sqmm
Layer 3	**20 mm**	**0**	0 sqmm
			0 sqmm

0.000 %

Sectional Dimensions
OK
Shear Reinforcements
required

Steel	**415 MPa**		Vus/d	1.610 kN/cm	1.610
Type of stirrup	**2 legged**				
Stirrup diameter	**8 mm**				
Spacing	272 c/c	Safe			

b. beam design – B2

Beam Data

width	**200 mm**	d'	48 mm	*.= cc+ sdia + mdia/2*
depth	**600 mm**	eff depth	552 mm	*.= d - d'*
clear cover to main reinf.	**30 mm**			
Slab Thickness	**125 mm**			

Material Grades

Concrete	**30 MPa**

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				Span Moment	Support Moment
Steel	500 MPa				
Span Moment	212 KN-m		Mu/bd²	3.48	3.64
			xumax	252	252
			Mulim	243	243
Support Moment	222 KN-m	222 KN-m	Mulim/bd²	3.99	3.99
		0 KN-m			

Span Reinforcement
Beam is designed as Singly Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)	
Percentage	0.951 %	------	*Refer Table 2 SP 16 pg 48*
Area of Steel	1050 sqmm		

434 KN-m

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel	
Layer 1	20 mm	0	0 sqmm	
Layer 2	20 mm	4	1257 sqmm	2042 sqmm
Layer 3	20 mm	0	0 sqmm	
		Total Steel Provided	1257 sqmm	1.138 %
		Provided Steel OK		

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel	
Layer 1	16 mm	0		
Layer 2	25 mm	0		
Layer 3				
	Total Steel Provided			#VALUE!

Support Reinforcement
Beam is designed as Singly Reinforced Beam

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Area of Steel	Tension (Ast)	Compr (Asc)	
Percentage	1.007 %	-------	*Refer Table 2 SP 16 pg 48*
Area of Steel	1112 sqmm		

2.25375125148833
-0.164187656182662

Tension Reinforcement

-0.056142565301946

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	0	0 sqmm
Layer 2	20 mm	2	628 sqmm
Layer 3	16 mm	3	603 sqmm
	Total Steel Provided		1232 sqmm
	Provided Steel OK		

1.115 %

1832 sqmm
1473 sqmm

Compression Reinforcement

2514 sqmm

Type	Bar dia	Nos	Area of Steel
Layer 1	16 mm	0	
Layer 2	20 mm	0	
Layer 3			
	Total Steel Provided		

#VALUE!

Shear Force (Vu)	169 KN		
ζv	1.531	*=Vu / (b * d)*	*or =(0.85*√(0.8*fck)*√(1+5β) -1)) / (6β)*
ζc	0.689	*Refer Table 61 SP 16 pg 179*	
ζcmax	3.5	*Refer Table J SP 16 pg 175*	

Type	Bar Dia	Nos	Area of Steel
Layer 1	25 mm	0	0 sqmm
Layer 2	25 mm	0	0 sqmm

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Layer 3	20 mm	0	0 sqmm		
			0 sqmm	0.000 %	

Sectional Dimensions OK
Shear Reinforcements required

Steel	**415 MPa**		Vus/d	1.684 kN/cm	1.684
Type of stirrup	**2 legged**				
Stirrup diameter	**8 mm**				
Spacing	260 c/c	Safe			

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3.4 TWO WAY SLAB DESIGN

a. slab design – S1

Slab thickness	t	125 mm
Concrete	fck	25 MPa
Steel	fy	500 MPa

Sunken Depth: 0 mm

Loading

Slab Load

Dead Load	DL	3.125 KN/m
Live Load	LL	2.000 KN/m
Finishes Load	WL	1.000 KN/m
Total Load	Ws	6.125 KN/m
Factored Load	Wsu	9 KN/m

Sunken Slab Load

Dead Load	DL	3.125 KN/m
Filler Load	FL	0 KN/m
Live Load	LL	3.0 KN/m
Finishes Load	WL	1.0 KN/m
Total Load	Wsk	7.13 KN/m
Factored Load	Wsku	11 KN/m

Slab Data

Slab Type	Regular
Load	9 KN/m
Longer Span (ly)	6.80 m
Shorter Span (lx)	4.30 m

ly/lx ratio	1.58
Slab type	+

Loading on edges		*one way*	*two way*
W_{longer}	**17 KN/m**	$=w*lx/2$	$=(w*lx/2) + (1-(1/3)*(lx/ly)^2)$
$W_{shorter}$	**13 KN/m**		$=w*lx/3$

Moments		*one way*	*two way*
Mx	15 KN-m	$=w*lx^2/8$	$=ax * w*lx^2$
My	10 KN-m		$=ay * w*lx^2$

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Slab Data

Slab Type	Regular
Load	9 KN/m
Longer Span (ly)	3.50 m
Shorter Span (lx)	4.50 m

ly/lx ratio	0.78
Slab type	+

Loading on edges		one way	two way
W_{longer}	**9 KN/m**	.=w*lx/2	.=(w*lx/2) + (1-(1/3)*(lx/ly)^2)
$W_{shorter}$	**14 KN/m**		.=w*lx/3

Moments		one way	two way
Mx	7 KN-m	.=w*lx^2/ 8	.=αx * w*lx^2
My	10 KN-m		.=αy * w*lx^2

Thickness Check	OK	.=Mulim > Mux or Muy
Deflection	4 mm	.= 5*W*l^4/(384EI)

Area of Steel	Astx	Asty
	161 sqmm	**239 sqmm**

Refer Chart 4 SP 16 pg 21
Refer Table 5-44 SP 16 pg 51-80

or

Spacing required in mm

8#		10#		12#		16#	
x	y	x	y	x	y	x	x
313 c/c	**210 c/c**	**489 c/c**	**329 c/c**	**704 c/c**	**473 c/c**	**965 c/c**	**841 c/c**

*.=ast of bar*1000/ast req*

Final Ast provided	x	y
	8# @ 250c/c	**8# @ 150c/c**

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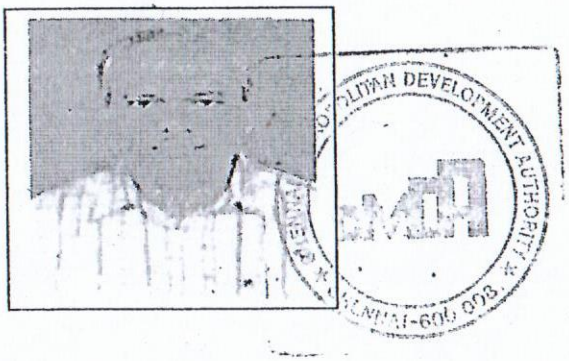
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PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru P. RAMAN** has enrolled as **Registered Structural Engineer Grade-I (SE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Structural Engg.)** and experience in the relevant field for **18years**.

He has been given the Registration No.**SE/GR-I/2024/02/006** on **27.02.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **26.02.2029**.



23/2/24

(A. MEGANATHAN)
Superintendent

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