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STRUCTURAL STABILITY CERTIFICATE AND DESIGN CALCULATIONS

Name of work : Plan showing the proposed residential building in survey no. 142/A / 1C1 at Kilaambakkam village, Chengalpet taluk, Kancheepuram district.

Preamble:

1.the usage of the building-Stilt floor + 5 upper floors.

2 The Super Structure is built on outer 200mm walls and inner 100mm walls.

3. Concrete grade for RCC members is M30 grade concrete.

4. The SBC of the soil is 15Ton/sq.m.

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

This is to certify that the Structural Design of the proposed construction of residential building at above said site has been DESIGNED on the basis of EARTHQUAKE RESISTANT DESIGN OF STRUCTURES IS 1893 (Part1): 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.

ADDITIONAL CRITERIA

1. The structure is idealized as Special RC-Moment Resisting Frame (SMRF) and analyzed using software package (STAAD PRO) for both vertical and lateral loads.
2. The lateral load includes wind load and earthquake load, Seismic load of medium and moderate intensity of ZONE-III considered is for design and analysis purpose.
3. The Foundation is designed for critical un-Factored load combinations.
4. The Superstructure members are designed for actual flexure, shear and forces.
5. The structure is analyzed for specific loads (Dead and Live Loads) and for the load combinations given in relevant loads.
6. The design of the structure is **structurally sound and safe.**

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2. DESIGN CALCULATIONS.

CALCULATION OF SEISMIC CO-EFFICIENT

Name of city	: Kilaambakkam
Type of Building	: Residential Building
Building Frame System	: Special RC-Moment resisting frame (SMRF)
Fundamental Natural Period (Ts)	: (0.09*h/(d^0.5))=0.41sec.
Soil conditions	: medium
Zone Factor (Refer Table:2) (Z)	: 0.16 (moderate)
Importance Factor (Refer Table:6) (I)	: 1
Response Reduction (Refer Table:7)	: 5.0
Average response acceleration Co-efficient (Sa/g)	: 2.5

EARTH QUAKE ANALYSIS:

Horizontal Seismic Co-efficient (Ah)	= (Z/2)(I / R)(Sa/g) = (0.16/2) (1/5.0) (2.5) = 0.04
Design value of Ah	= 0.04
Type of Foundation	: Strip Raft foundation

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

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2. LOADING ON SLAB:

2.1 Loading on Roof slab:

Roof finished with lime concrete terracing	=(0.10)(20)	=2.000kN/m^2
S/W of slab 150mm thick	=(.150)(25)	=3.75kN/m^2
Dead load	=5.75kN/m^2	
Live load	=1.50kN/m^2	
Total load on Roof	= 7.25kN/m^2	

2.2 Loading on Floor slabs:

Floor finish	= 1.00kN/m^2
S/w of slab 150mm thick	= 3.75kN/m^2
Dead load	=4.75kN/m^2
Live load	=2.00kN/m^2
Total load on Roof	= 6.75kN/m^2

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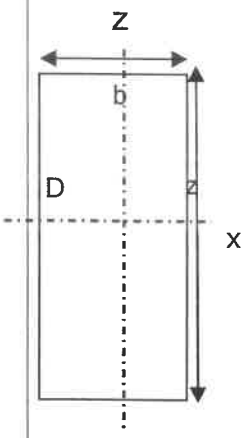
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DESIGN CALCULATION

3 DESIGN:

3.1 COLUMN DESIGN

Grade of Concrete			M 30	
Characteristic Strength of Reinf.		N/mm^2	500	
Width of Column	b	mm	600	
Depth of Column	D	mm	300	
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	2313.000	1
Factored Moment	M_{ux}	kN.m	46.000	1
Factored Moment	M_{uz}	kN.m	123.000	1
Effective Length of Column	l_{ex}	mm	3600	1.2
	l_{ez}	mm	3600	1.2
	l_{ex}/D		12	0
			<12- Short Column	
	l_{ey}/b		6	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		3	
Gross Area of Cross Section	A_g	mm^2	180000	
Ultimate Axial Load	P_{uz}	kN	4382.1	
d'/D (about x-x axis)			0.175	0.2



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d'/D (about y-y axis)			0.088	0.1
(Table 60)	k1		0.184	
	k2		0.028	
	P_{bx}	kN	1008.720	
	k1		0.207	
	k2		0.328	
	P_{bz}	kN	1294.920	
	k_x		0.613	
	k_y		0.670	
Minimum Eccentricity	e_x	mm	16	
	e_y	mm	26	
Moments due to min. eccentricity	M_{ex}	kN.m	37.01	< 46.000 kN.m
Moments due to min. eccentricity	M_{ez}	kN.m	60.14	< 123.000 kN.m
Total Moments for which the column is to be designed are				
	M_{ux}	kN.m	46.000	
	M_{uz}	kN.m	123.000	
The section is to be checked for biaxial bending				
	$P_u/f_{ck}bD$		0.428	
	p/f_{ck}		0.1	
Referring (d'/D is 0.2)	$M_u/f_{ck}bD^2$		0.11	
	M_{ux1}	kN.m	178.200	
Referring to (d'/D = 0.1)	$M_u/f_{ck}bD^2$		0.140	
	M_{uy1}	kN.m	453.600	
	M_{ux}/M_{ux1}		0.258	
	M_{uy}/M_{uy1}		0.271	
	P_u/P_{uz}		0.528	
		a	1	1.5467 < 1
Mux/Mux1 + Muy/Muy1			0.256	OK
Area of Reinforcement	As	mm^2	5400	
Minimum no of to be provided			6	
No of Bars to be provided	Nos.		12	
Provide 12 Nos of 25 Diameter				

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3.2 FOUNDATION DESIGN

3.2.1 STRIP RAFT FOOTING DESIGN

3.2.1.1 RAFT BEAM – RB1:

Beam Data

width	700 mm
depth	700 mm
clear cover to main reinf.	50 mm
Slab Thickness	250 mm

d' = 71 mm *.= cc+ sdia + mdia/2*

eff depth = 630 mm *.= d - d'*

Material Grades

Concrete	30 MPa
Steel	500 MPa

	Span Moment	Support Moment
Mu/bd²	0.00	2.99
xumax	287	287
Mulim	1107	1107
Mulim/bd²	3.99	3.99

Span Moment	0 KN-m	
Support Moment	829 KN-m	829 KN-m
		0 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	749 sqmm	

Refer Table 2 SP 16 pg 48

829 KN-m

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	8	3927 sqmm
Layer 2	20 mm	0	0 sqmm
Layer 3	20 mm	0	0 sqmm
		Total Steel Provided	3927 sqmm

4421 sqmm

0.891 %

Provided Steel OK

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Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	16 mm	0	
Layer 2	20 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	0.792 %	------	*Refer Table 2 SP 16 pg 48*
Area of Steel	3491 sqmm		

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	8	3927 sqmm
Layer 2	20 mm	0	0 sqmm
Layer 3	12 mm		0 sqmm
Total Steel Provided			3927 sqmm
Provided Steel OK			0.891 %

1.78236278996357

-0.721181394981786

-0.622131789249019

4211 sqmm
3852 sqmm

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	20 mm	0	
Layer 2	25 mm	0	
Layer 3			
Total Steel Provided			#VALUE!

4893 sqmm

Shear Force (Vu)	820 KN		
ζv	1.802	*.=Vu / (b * d)*	
ζc	0.627	*Refer Table 61 SP 16 pg 179*	*or =(0.85*√(0.8*fck)*√(1+5β)-1)) / (6β)*
ζcmax	3.5	*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	500 MPa
Type of stirrup	6 legged
Stirrup diameter	8 mm
Spacing	152 c/c

Not Safe

Vus/d 8.636 kN/cm 8.636

3.3 BEAM DESIGN

Beam Data

width	200 mm
depth	600 mm
clear cover to main reinf.	25 mm
Slab Thickness	125 mm

d' 43 mm .= cc+ sdia + mdia/2
eff depth 557 mm .= d - d'

Material Grades

Concrete	30 MPa
Steel	500 MPa

	Span Moment	Support Moment
Span Moment 121 KN-m	Mu/bd²	1.95	4.56
	xumax	254	254
	Mulim	248	248
Support Moment 283 KN-m / 283 KN-m	Mulim/bd²	3.99	3.99
0 KN-m			

Span Reinforcement
Beam is designed as Singly
Reinforced Beam

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Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.488 %	------
Area of Steel	544 sqmm	

Refer Table 2 SP 16 pg 48

404 KN-m

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	20 mm	3	942 sqmm
Layer 2	20 mm	3	942 sqmm
Layer 3	25 mm	0	0 sqmm
Total Steel Provided			1885 sqmm

2349 sqmm

1.692 %

Provided Steel OK

Compression Reinforcement

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

#VALUE!

Support Reinforcement
Beam is designed as Doubly Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	1.274 %	0.155 %
Area of Steel	1419 sqmm	173 sqmm

Refer Table 45-56 SP 16 pg 81-92

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	20 mm	3	942 sqmm
Layer 2	20 mm	3	942 sqmm
Layer 3			0 sqmm
Total Steel Provided			1885 sqmm

3.38412135036603

-1.203850642586300

-0.785897531029734

1.692 %

Provided Steel OK

2139 sqmm

1780 sqmm

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Compression Reinforcement

2821 sqmm

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

0.000 %

Provided Steel Insufficient

Shear Force (Vu)	**182 KN**		
ζv	1.634	.=Vu / (b * d)	
ζc	0.796	*Refer Table 61 SP 16 pg 179*	*or =(0.85*√(0.8*fck)*√(1+5β)-1)) / (6β)*
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	**500 MPa**	Vus/d	1.676 kN/cm	1.676
Type of stirrup	**2 legged**			
Stirrup diameter	**8 mm**			
Spacing	261 c/c	Safe		

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3.4 SLAB DESIGN

Slab thickness	t	150 mm
Concrete	fck	30 MPa
Steel	fy	500 MPa

Sunken Depth	0 mm

Loading

Slab Load

Dead Load	DL	3.750 KN/m
Live Load	LL	2.000 KN/m
Finishes Load	WL	1.000 KN/m
Total Load	Ws	6.750 KN/m
Factored Load	Wsu	10 KN/m

Sunken Slab Load

Dead Load	DL	3.750 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	7.75 KN/m
Factored Load	Wsku	12 KN/m

Slab Data

Slab Type	Regular
Load	10 KN/m
Longer Span (ly)	5.30 m
Shorter Span (lx)	3.30 m

ly/lx ratio	1.61
Slab type	+

Loading on edges		*one way*	*two way*
W_{longer}	**15 KN/m**	*.=w*lx/2*	*.=(w*lx/2) + (1-(1/3)*(lx/ly)^2)*
$W_{shorter}$	**11 KN/m**		*.=w*lx/3*

Moments		*one way*	*two way*
Mx	10 KN-m	*.=w*lx^2/ 8*	*.=αx * w*lx^2*
My	6 KN-m		*.=αy * w*lx^2*

Thickness Check	OK	*.=Mulim > Mux or Muy*
Deflection	14 mm	*.= 5*W*l^4/(384EI)*

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Area of Steel	Astx	Asty
	178 sqmm	**180 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
283 c/c	**279 c/c**	**442 c/c**	**436 c/c**	**637 c/c**	**628 c/c**	**#######**	**1117 c/c**

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

Final Ast provided	x	y
	10# @ 100c/c	**10# @ 150c/c**

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