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STRUCTURAL STABILITY CERTIFICATE

Name of work: Plan showing the proposed construction of stilt + 5 floors Office cum residential building with one dwelling unit at old door No:12, new no:5, plot no:270 C, E-block, 1st street, Anna nagar east, Chennai-600 102. In T.S.no:118 part (as per doc), old s.no:44/ 1 part, 44 /4 part and 46 part, T.S.no:118/8 (as per patta) block no:1, of Periyakudal village, Aminjikarai Taluk, within the limit of greater Chennai Corporation, Zone : VIII, division - 101

Preamble

- : 1. I hereby certify that the structural design sheet is done for column, Foundation, Slab and beam.
2. The usage of the building is Ground floor + 5 upper Floors.
3. The Super Structure is built on outer 230mm walls and inner 115mm walls.
4. All concrete for RCC members in Ground + 5 Floors are M40 concrete.
5. The structural design includes the Earth quake Criteria as per IS: 1893(part 1)-latest revision.

ADDITIONAL CRITERIA

1. The structure is idealized as Special RC-Moment Resisting Frame (SMRF) and analyzed using software package (ETABS) 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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For HEXEL REACTORS PRIVATE LIMITED

DIRECTOR

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This is to certify that the Structural Design of the proposed construction of Office cum 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.

CALCULATION OF SEISMIC CO-EFFICIENT

Name of city	: Chennai
Type of Building	: Office cum Residential Building
Building Frame System	: Special RC-Moment resisting frame (SMRF)
Fundamental Natural Period (Ts)	: $(0.075)h^{3/4} = 0.655\text{sec.}$
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)	: 2.4

EARTH QUAKE ANALYSIS:

Horizontal Seismic Co-efficient (Ah)	$= (Z/2)(I/R)(Sa/g)$ $= (0.16/2)(1.2/5.0)(2.35)$ $= 0.045$
Design value of Ah	$= 0.045$
Type of Foundation	: Pile Foundation

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1. GENERAL LOADING CONDITIONS:

(a) Imposed loads on Roof	- 1.50kN/m ²
(b) Imposed loads on Office	- 4.00kN/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 150mm thick	= (.15)(25) = 3.625kN/m ²
Dead load	= 5.625kN/m ²
Live load	= 1.50kN/m ²
Total load on Roof	= 7.125kN/m ²

2.2 Loading on Floor slabs:

Floor finish	= 1.00kN/m ²
S/w of slab 150mm thick	= 3.725kN/m ²
Dead load	= 4.725kN/m ²
Live load	= 4.00kN/m ²
Total load on Roof	= 8.725kN/m ²

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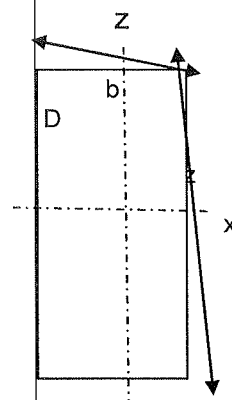
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3 DESIGN:

3.1 COLUMN DESIGN

Grade of Concrete				M 40	
Characteristic Strength of Reinf.		N/mm ²	500		
Width of Column	b	mm	600		
Depth of Column	D	mm	600		
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	260.000	1	
Factored Moment	M_{ux}	kN.m	130.000	1	
Factored Moment	M_{uz}	kN.m	316.000	1	
Effective Length of Column	l_{ex}	mm	3600	1.2	
	l_{ez}	mm	3600	1.2	
	l_{ex}/D		6	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		2.6		
Gross Area of Cross Section	A_g	mm ²	360000		
Ultimate Axial Load	P_{uz}	kN	9821.52		
d'/D (about x-x axis)			0.088		
d'/D (about y-y axis)			0.088	0.1	
(Table 60)	k_1		0.207		



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	k2		0.328	
	P _{bx}	kN	3287.808	
	k1		0.207	
	k2		0.328	
	P _{bz}	kN	3287.808	
	k _x		1.000	
	k _y		1.000	
Minimum Eccentricity	e _x	mm	26	
	e _y	mm	26	
Moments due to min. eccentricity	M _{ex}	kN.m	6.76	< 130.000 kN.m
Moments due to min. eccentricity	M _{ez}	kN.m	6.76	< 316.000 kN.m

Total Moments for which the column is to be designed are

	M _{ux}	kN.m	130.000	
	M _{uz}	kN.m	316.000	

The section is to be checked for biaxial bending

	P _u /f _{ck} bD		0.018	
	p/f _{ck}		0.065	
Referring (d'/D is 0.1)	M _u /f _{ck} bD ²		0.07	
	M _{ux1}	kN.m	604.800	
Referring to (d'/D = 0.1)	M _u /f _{ck} bD ²		0.070	
	M _{uy1}	kN.m	604.800	
	M _{ux} /M _{ux1}		0.215	
	M _{uy} /M _{uy1}		0.522	
	P _u /P _{uz}		0.027	
	a		0	1
				< 1
Mux/Mux1 + Muy/Muy1			0.737	OK
Area of Reinforcement	As	mm ²	9360	
Minimum no of to be provided			8	
No of Bars to be provided	Nos.		20	
Provide 20 Nos of 25 Diameter				

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3.2 FOUNDATION DESIGN

3.2.1 PILE CAP DESIGN

Concrete
 Grade: M40
 Steel : Fe 500

BASE SLAB						
Bending moment		Req.depth	Total depth	Bar dia.	Clear cover	Effect. depth
(Mu)		(D)	(D)			(d)
(kN-m/m)		(mm)	(mm)	(mm)	(mm)	(mm)
Mx (+) =	12.80	92.38	1000	20	50	940
Mx (-) =	782.00	722.03	1000	20	50	940
My (+) =	22.00	121.11	1000	20	50	940
My (-) =	681.00	673.80	1000	20	50	940

Width	Mu/bd ²	p _r required	Ast required	S required	S provided	p _r provided	Remarks
(b)							
(mm)		(%)	(mm ² /m)	mm c/c	mm c/c	(%)	
1000	0.014	0.170	1598.00	197	125	0.267	20Y @ 125
1000	0.885	0.210	1974.00	159	125	0.267	20Y @ 125
1000	0.025	0.170	1598.00	197	125	0.267	20Y @ 125
1000	0.771	0.182	1710.80	184	125	0.267	20Y @ 125

Check for Shear stresses :				
Shear stress		p _r provided	τ _c	Remarks
(τ _v)			table 19, IS:456	
(N/mm ²)		(%)	(N/mm ²)	
SQx =	0.294	0.267	0.387	safe
SQy =	0.210	0.267	0.387	safe

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3.3 BEAM DESIGN

Beam Data

width	450 mm	d'	46 mm	$\therefore cc + sdia + mdia/2$
depth	700 mm	eff depth	655 mm	$\therefore d - d'$
clear cover to main reinf.	25 mm			
Slab Thickness	150 mm			

Material Grades

Concrete	30 MPa
Steel	500 MPa

Span Moment	352 KN-m	Mu/bd ²	1.83	2.45
		xumax	298	298
		Mulim	769	769
Support Moment	472 KN-m	Mulim/bd ²	3.99	3.99
	472 KN-m			
	0 KN-m			

Span Reinforcement

Beam is designed as Singly
Reinforced Beam

Area of Steel	Tension (Ast)	Compr (Asc)
Percentage	0.454 %	-----
Area of Steel	1338 sqmm	

Refer Table 2 SP 16 pg
48

824 KN-m

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	6	2945 sqmm
Layer 2	20 mm	0	0 sqmm
Layer 3	20 mm	0	0 sqmm
Total Steel Provided			2945 sqmm
Provided Steel OK			

2783 sqmm

1.000 %

Compression Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	6	

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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	0.629 %	-----
Area of Steel	1853 sqmm	

Refer Table 2 SP 16 pg
48

Tension Reinforcement

Type	Bar dia	Nos	Area of Steel
Layer 1	25 mm	6	2945 sqmm
Layer 2	20 mm	0	0 sqmm
Layer 3	12 mm		0 sqmm
Total Steel Provided			2945 sqmm
Provided Steel OK			

1.000 %

1.99999532314094

-0.545638773922828

-0.174839386681158

2573 sqmm

2214 sqmm

Compression Reinforcement

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

#VALUE!

3255 sqmm

Shear Force (Vu)

313 KN

ζ_v

1.030

$=Vu / (b * d)$

ζ_c

0.656

Refer Table 61 SP 16 pg 179

ζ_{cmax}

3.5

Refer Table J SP 16 pg 175

or
 $= (0.85 * \sqrt{0.8 * f_{ck}}) * \sqrt{(1 + 5\beta - 1)) / (6\beta)}$

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Type	Bar Dia	Nos	Area of
------	---------	-----	---------

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			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	2 legged	
Stirrup diameter	10 mm	
Spacing	239 c/c	Safe

Vus/d

1.831 kN/cm

1.831

3.4 TWO WAY SLAB DESIGN

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

Sunken Depth	0 mm
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Loading

Slab Load

Dead Load	DL	3.750 KN/m
Live Load	LL	4.000 KN/m
Finishes Load	WL	1.000 KN/m
Total Load	Ws	8.750 KN/m
Factored Load	Wsu	13 KN/m

Sunken Slab Load

Dead Load	DL	3.750 KN/m
Filler Load	FL	0 KN/m
Live Load	LL	2.0 KN/m
Finishes Load	WL	1.0 KN/m
Total Load	Wsk	6.75 KN/m
Factored Load	Wsku	10 KN/m

Slab Data

Slab Type	Regular
Load	13 KN/m
Longer Span (ly)	5.80 m
Shorter Span (lx)	4.00 m

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1.45

+

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Loading on edges		one way	two way
W_{longer}	22 KN/m	$=w \cdot l_x/2$	$=(w \cdot l_x/2) + (1 - (1/3) \cdot (l_x/l_y)^2) \cdot w \cdot l_x/3$
W_{shorter}	18 KN/m		
Moments		one way	two way
M_x	18 KN-m	$=w \cdot l_x^2/8$	$=\alpha_x \cdot w \cdot l_x^2$
M_y	12 KN-m		$=\alpha_y \cdot w \cdot l_x^2$
Thickness Check		OK	
Deflection		25 mm	
		$=M_{\text{ulim}} > M_{\text{ux}} \text{ or } M_{\text{uy}}$	
		$=5 \cdot W \cdot l^4 / (384EI)$	

Area of Steel	Astx	Asty	Refer Chart 4 SP 16 pg 21 Refer Table 5-44 SP 16 pg 51-80
	338 sqmm	214 sqmm	

or

Spacing required in mm

8#		10#		12#		16#	
x	y	x	y	x	y	x	x
149 c/c	235 c/c	233 c/c	367 c/c	335 c/c	529 c/c	595 c/c	940 c/c

$= \text{ast of bar} \cdot 1000 / \text{ast req}$

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

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