DESIGN CALCULATION

PLAN SHOW THE PROPOSED BUILDING COMSTRUCTION OF STILT + 3 FLOOR (HEIGHT -13.02M) RESIDENTIAL APARTMENT BUILDING 18 DWELLING UNITS AT T.S NO: 865 & 866, WARD NO:1,BLOCK NO: 24, AT BANADURAI NORTH STREET , KUMBAKONAM TOWN , KUMBAKONAM CORPORATION , THANJAVUR DISTRICT.

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Structural Design Calculation for Construction of RESIDENTIAL APARTMENT BUILDING(S+3) AT KUMBAKONAM

1.0 DESIGN BRIEF:

THIS DOCUMENT PLAN SHOW THE PROPOSED BUILDING COMSTRUCTION OF STILT + 3 FLOOR (HEIGHT -13.02M) RESIDENTIAL APARTMENT BUILDING 18 DWELLING UNITS AT T.S NO: 865 & 866, WARD NO:1,BLOCK NO: 24, AT BANADURAI NORTH STREET , KUMBAKONAM TOWN , KUMBAKONAM CORPORATION , THANJAVUR DISTRICT.

2.0 GENERAL DESIGN CRITERIA:

2.1 Project Description

The Residential apartment building consists of stilt +3 floor and the structural design as a R.C.C framed structure.

1.Size of Building	: 7.70m x 67.98m
2.Height of building	: 13.02 m
3.Number of storey	: stilt +3 floor
4.Floor to floor height	: stilt -3.0m , typical floor3.18 m
5.Type of foundation	: Pile foundation with pile cape as per geotechnical report

2.2 Material used

Concrete Grade	: M25
Steel Grade	: Fe500
Potation Wall(Masonry)	: Bricks /ACC Block

2.3 Design Codes & standards

Following codes and specification have been generally used in the design of the members of the structural

- S 456 : 2000 Code of practice for Plain and Reinforced concrete
- SP: 16 Design Aids for Reinforced concrete
- IS 875 : 1987 Design Loads for building and structures
- IS 1893 : 2002 Criteria for Earthquake Resistant design of structures
- IS 13920: 1993 Ductile Detailing of R.C structures subjected to Seismic forces
- SP: 34 Handbook on Concrete Reinforcement & Detailing
- IS 800 : 1984 Code of practice for general construction in steel
- IS 2062 : 1999 Steel for general structural purposes specification
- IS 1786: 1985 Specification for high strength deformed bars and wires for concrete reinforcement

Structural Design Calculation for Construction of RESIDENTIAL APARTMENT BUILDING(S+3) AT KUMBAKONAM

3.0 LOADING

1. Dead load

2.Live load

3.1 Dead Load (DL):

- Density of Concrete -25 kn/m^3
- Unit weight of Partition wall -19 kn/m^3
  (Light partition as per I S875) -1.50 kn/m^2
- D.L due to floor finishing 50mm tk - 0.05x25 = 1.25 1.50 kn/m^2

3.2 Live Load(LL)

Minimum uniformly distributed live laods

Occupancy or use	**Live Load (kn/m^2)**
• All rooms and kitchens	2.00
• Toilet and bath rooms	3.00
• Corridors, passages, staircases	3.00
• Balconies	3.00
• Terrace Floor	1.50
• Basic wind speed	=20 m/sec
• Seismic Zone	=Zone II

3.5 Loading Combinations

The following combinations of Loads as per IS 1893 is considered in the STAAD Analysis

- 1.5(DL +LL)
- 1.2(DL + LL)

The below load combinations are used to check the structure in serviceability condition.

- 1.0(DL +LL)

4.0 STRUCTURAL MATERIAL:

4.1 Concrete Material Specifications:

- Concrete compressive cube strength - 25 N/mm^2
- Minimum cement content - Refer standard drawings for general & Legends
- Cement type - OPC

- Free water cement ratio - 0.5 (Maximum)
- Nominal maximum size of aggregate - 20mm UNO

4.2 Reinforcement:

Steel reinforcement shall be deformed bars, the characteristic of reinforcement bars shall conform to

the following specification:

- Grade of Steel Actual Yield Strength (MPa)
- Grade Fe500 Minimum 500 MPa,

4.3 Concrete cover:

Cover for Reinforcement is considered as per Table 16A of NBC, for a Fire resistance of 2 hrs.

- Raft Slab = 50mm
- Footing = 80mm
- Columns = 40mm
- Beams = 30mm
- Roof Slab = 25mm

5.0 Structural Description

5.1. Method of analysis

- Structure analysis & design:
- The structure is analyzed as a Space frame structure in STADD Pro Vi8. Columns, Footing, Basement
- walls, slabs, Beams and Staircases are designed as reinforced concrete members.

5.2. Framing System, Analysis and Design

- Limit State concept of design will be used as per IS: 456-2000 & SP - 16. The detailing of
- reinforcement shall be done satisfying the requirements of IS: 456-2000, SP-16, IS: 13920, IS: IS 4326-1993 AND SP-34
- The Slabs and beams are checked for deflection as per IS 456:2000. Cover for Reinforcement is considered as per Table 16A of NBC, for a Fire resistance of 2 hrs.

APPENDEX -1

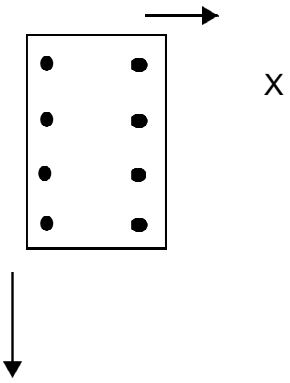
DESIGN CALCULATION

COLUMN DESIGN

Constructed Apartment Design Calculation / Verification for the Maximum Loading Column C1 are Inter sectored are below

Column data

Width of column - b =	**530**	mm
Depth ofcolumn - h =	**300**	mm
Clear height - H =	**3.1**	m
Design axial load -Pu =	**350**	kn
Ultimate moment about - x - Mx1 =	**21**	kn-m
Ultimate moment about - y - My1 =	**3.468**	kn-m



Concrete&reinforcement data

Charasteric strength of concrete - f_{cu} =	**25**	N/mm^2
Charasteric strength of reinfor.- fy =	**500**	N/mm^2
Clear cover to rings - c =	**40**	mm
Dia of rings	**8**	mm
Dia of reinforcement =	**16**	mm
Number of Bars =	**10**	Nos

Check for slenderness

Check about y - axis

Type of restraint about y - axis =	**Unbraced**		
End condition at top =	**1**		
End condition at bottom =	**1**		
$ß_1$ =	**1.6**		
lex =	4.96	m	
lex/b =	9.36	<	10
	short		

Check for slenderness

Check about x - axis

Type of restraint about y - axis =	**Unbraced**		
End condition at top =	**1**		
End condition at bottom =	**1**		
$ß_1$ =	**1.2**		
ley =	12	m	
ley/h =	12.40	>	10
	slender		

Case - 1 - Design check by assuming min.ecc.

Axial capacity of column =	N=	$0.35f_{cu}Ac+0.67\ fyAsc$	
	.=	2064.807	kn
		>	Design axial load
		ok	

Case 2 Max axial laod +bending

Design check for biaxial bending	h' =	244	
	b'=	474	
The ratio =	Mx/h' =	86.07	
The ratio =	My/b' =	7.32	
Tthe ratio=	N/bhfcu =	0.09	
	ß=	**0.65**	
	Mx'=Mx+beta(h'/b,)My		
=	22.2	kn-m	
Design width of section b =	**450**	mm	
Design depth of section h =	**230**	mm	
Effective depth d=	174	mm	
The ratio- N/bh =	3.4		
The ratio- M/bh^2 =	0.9		
Refering Bs 8110,part-3 chart no 32			
d/h =	0.76		
The ratio :- 100As/bh =	**0.40**	%	
Reinforcement required As =	414		
Reinforcementprovided Ap =	2010.6	ok	

Provide 300mmx530mm =Provide 4 # 20mmØ + 4 # 16mmØ

PILE CAP DESIGN

PILE FOOTING FOR COLUMN C3C:

Design of pile cap :-for column C

1.Column Size = 300mm x 450mm

Axial Load = 1050.00 kN

Center to center Spacing of pile = 1.00 m

2.Dimension of pile cap:

Center to center Spacing of pile = 1.00 m

Keeping 1.50mm clear projection of the up beyond pile face overall length of the cap along the direction
AB =1.00+0.38+0.30+0.15

=1.83 m

Length of beam

CD = 1 =L √3/2

= 1x√3/2 = 0.86 M

Length of cap in the direction

DC = 0.86+0.38+0.30

=1.54 m

3. Design of beam DC:

Load on each pile

Width of column =300mm

Bending moment due to load

WI/3√3 = 1050x1.0/3√3

202.30 kM.m=202.30x10^6 N-mm

In order to calculation the bending momentdue to self weight ot the beam plus weight of the part of slab let us assume total thickness of slab to be 530mm.

The self weight of the beam is calculated on the assumption that weight of slab equal to two time the width of the beam acts with the beam.

$$\frac{3x3003530x1x2500}{10^6}$$

=11925 N/m

Length of beam

L=L √3 /2 = 0.86m

Total load :

0.86x11925 = 10255.50 kN

Reaction at C

=10255.50 / 2 =5127 N

Distance of point of application of column load =2x1 / 3 =0.66m

B.M at the center of column due to self weight is

$$=5127x0.66-\frac{11925(0.66)^2}{2}$$

= 3383.82-2597.25= 785 N-m

= $0.79x10^6$ N-mm

Total Bending moment

202.30+0.79 =$203.09x10^6$ N-mm

$$D=\frac{\sqrt{203.09x10^6}}{0.874x450}$$

D=600mm

$$Ast=\frac{\sqrt{203.09x10^6}}{140x0.865x600}$$

Ast=2795mm^2

Provided 16mmØ @ 150mm c/c(Both way)

Pile Cap Thickness = 600mm

FLOOR BEAM DESIGN

Design of doubly reinforced beam
moment at span

span =	**4.5**	m		
Mu =	**255**	kn-m		
fy =	**500**	mm		
b =	**230**	mm		
D =	**550**	mm		
cover =	**40**	mm		
dia of bar =	**20**	first layer		
	20	second layer		
d =	480			
The required depth =	225	mm	refer(clause 23.2.1)of IS 456 2000	
fck =	**25**			
Mu limit =		$0.138 f_{ck} b d^2$ =	182.8	kN-m
		182.8 <	255	
		doubly rein.sec..		
Balanced steal required p =		19.82xfck/fy =	0.99	%
Ast1 =	1094.1	mm^2		
moment to be taken by steel beam(Mu2) =		Mu-mulimit =	72.2	kn-m
ASt2 =	Mu2/(0.87xfyx(d-d'))			
	d' =	70	mm	
Ast2 =	405	mm2		
Total tension reinforcement =		Ast1+Ast2 =	1498.76	mm^2

Stress in compression steel

	d'/d =	0.146		
	fs =	344.2		
Area of compression reinforcement = Asc = As2x0.87/fs				
Asc =	511	mm2		
Bottom steel				
provide	**3**	of	**20**	at bott.
	2	of	**20**	extra at bot.
	Ast provided =	1570.8	< 1498.76	safe
Top steel				
provide	**3**	of	**20**	at top
	0	of	**16**	extra at top
Asc provided =	942.5	>	511	safe

moment at support

span =	**4.5**		
Mu =	**215**	kn-m	
fy =	**500**	mm	
b =	**230**	mm	
D =	**550**	mm	
cover =	**40**	mm	
dia of bar =	**20**	first layer	
	20	second layer	
d =	480		
The required depth =	225	mm	refer(clause 23.2.1)of IS 456 2000

fck = **20**

Mu limit = $0.138 f_{ck} b d^2$ = 146.3 kN-m

146.3 < 215

doubly rein.sec..

Balanced steal required p = 19.82xfck/fy = 0.79 %

Ast1 = 875.3 mm^2

moment to be taken by steel beam(Mu2) = Mu-mulimit = 68.7 kn-m

ASt2 = Mu2/(0.87xfyx(d-d'))

d' = 70 mm

Ast2 = 385 mm2

Total tension reinforcement = Ast1+Ast2 = 1260.68 mm^2

Stress in compression steel

d'/d = 0.146

fs = 344.2

Area of compression reinforcement = Asc = As2x0.87/fs

Asc = 487 mm2

Top steel

provide	**3**	of	**20**	at top	
	2	of	**16**	extra at top	
Ast provided =	1344.6	>	1260.7	mm^2	safe

Bottom steel

provide	**3**	of	**20**	at bot.	
	0	of	**16**	extra at bot.	
Asc provided =	942.5	>	487	mm^2	safe

Check for shear

shear force =		134	kn
shear stress =		1.21	N/mm^2
shear strength of concrete =			0.85xsqrt(0.8xfck)xsqrt(1+5β-1)/6β
		β =	0.8/6.89pt
pt at support =		pt=	100Ast/(bxd)
		.=	1.22
		β =	2.4
shear strength of concrete =		0.7	N/mm^2
max.shear strength of concrete =		0.0	

spacing of stirrups = 0.87xfyxAsv/((shear stress-concre. Shear stress)xb)

provide	8	mm dia	2	leg strirrups
Asv =	100.5	mm^2		
spacing of stirrups =		363	mm	
So provide Y	8	**7**	"c/c	

check for max. tension reinforcement

.=	.04xbxD =	5060	mm^2	
	provided tension steel at top =	1344.6	mm^2	safe
	provided tension steel at bot..	1570.8	mm^2	safe

FLOOR SLAB DESIGN

Design of two way slab S1

Short span	lx =	3.66	m	ly/lx	=	0.96		
Long span	ly =	3.50	m					
				Thickness	t =	**230**	mm	
Cont. short edges	=	0		Filling	=	0	mm	
Cont. long edges	=	0		Loads:				
				Dead load	=	70.00		
Short span coeff.	+ =	0.050		Filling	=	1.00		
	- =	0.000		Floor finish	=	3.00		
				Partition	=	2.00		
Long span coeff.	+ =	0.056		Live load	=	4.00		
	- =	0.000		Design load	w =	112.80	kN/m^2	
	Short span				*Long span*			
Max. B.M.	M =	75.6	kNm	Max. B.M.	M =	84.6	kNm	
K = M/bd^{2}fcu	=	0.086		K = M/bd^{2}fcu	=	0.106		TRUE
Z	=	183	mm	Z	=	168	mm	As min
As required	=	1186	mm^2	As required	=	1444	mm^2	410
								As
Dia. of bars	=	**10**	mm	Dia. of bars	=	**10**	mm	prvd.
Spacing of bars	=	**130**	mm	Spacing of bars	=	**150**	mm	2%
As provided	=	20	mm^2	As provided	=	524	mm^2	36%
				Actual				
Basic span/depth	=	20.0		span/depth	=	17.9		
				Allow.				
Mod. factor	=	-43.75		span/depth	=	-874.9		

Design of two way slab S1	23		10	@	13		10	@ 15

As for + moment		1186	mm^2
fs		14819	N/mm^2