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DESIGN OF STRUCTURE

The structure has been modeled in software "Staad Pro v8i". The columns and beams have been modeled as per plan. The slab has been given as plate model and loadings are applied as per IS Codal regulations. The wall load has been applied on beams as per plan.

The structure has been analyzed as three dimensional structure. The earthquake forces are applied as per IS 1893 -2002.

The loads on columns are taken and foundation is designed as per IS code. Beams and columns are designed by Staad Pro. The floor slab is designed manually using IS Codal regulations.

Soil bearing capacity as per soil report is 350 kN /m^2 and this has been considered in the design of foundation

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CERTIFICATE

The proposed residential & commercial building at **Coromandel Enclave, S.F No.398/1, Ward – 34, Block – 1, T.S No. 25/3B, Uppilipalayam Village, East Zone, Coimbatore** which has Stilt + Ground + 3 Floors of residential Building has been designed as per IS Codal regulations and the construction will be carried out as per Standard Engineering Practice and hence the building is certified to be structurally stable and sound.

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DESIGN OF SLAB

Data:

Concrete	M20	fck	=	20	N/mm²
Steel	Fe500	fy	=	500	N/mm²
Shorter Span		Lx	=	2.97	m
Longer Span		Ly	=	5.26	m
Assuming Depth of Slab		D	=	150	mm
Assuming Dia of reinf			=	8	mm
Clear Cover			=	20	mm
Eff.Depth of Slab		d	=	126	mm
Eff.Shorter Span		L_x	=	2.97	m
Eff.Longer Span		L_y	=	5.26	m

1.Load Calculations :

Self weight of slab	(0.15 x	20.00)	=	3.00	kN/m²
Ceiling Plastering			=	0.25	kN/m²
Floor Finish			=	1.00	kN/m²
Weathering Course (Weight Not Applicable)			=	0.00	kN/m²
Live load			=	2.00	kN/m²
Total Load			=	7.00	kN/m²
Load Factor			=	1.50	
Factored Load			=	10.50	kN/m²
Span Ratio		l_y/l_x	=	5.26/2.97	
			=	1.77	

2. Bending Moment Calculation:

Support Condition — Two Adjacent edges discontinuous

continuous)

From IS 456-2000 Table 26

αNx	=	0.086
αPx	=	0.065
αNy	=	0.047
αPy	=	0.035

Shorter Span

Negative Moment (support)

$Mnx = \alpha_{Nx} \times W_u \times L_x^2$

$= 0.086 \times 10.50 \times 2.97^2$

$= 7.97 kN.m$

Positive Moment (Mid Span)

$Mpx = \alpha_{px} \times W_u \times L_x^2$

$= 0.065 \times 10.50 \times 2.97^2$

$= 6.02 kN.m$

Longer Span:

Negative Moment (Support)

$MNy = \alpha_{Ny} \times W_u \times L_x^2$

$= 0.047 \times 10.50 \times 2.97^2$

$= 4.35 kN.m$

Positive Moment (Mid span)

$Mpy = \alpha_{py} \times W_u \times L_x^2$

$= 0.035 \times 10.50 \times 2.97^2$

$= 3.24 kN.m$

Reinforcement :

$$Mu = 0.87 \times fy \times Ast \times d \left\{ 1 - \frac{(fy \times Ast)}{fck \times bd} \right\}$$

$$= 0.87 \times 500 \times Ast \times 126 \quad 1 - \left\{ \frac{500 \times Ast}{20 \times 1000 \times 126} \right\}$$

Ast in Shorter Span

Support	$=149mm^2$
Mid Span	$=112mm^2$

Ast in Longer Span

Support	$=110mm^2$
Mid Span	$=90mm^2$

	Reinf Required		Reinf Provided
Shorter Span			
Support	8ø @ 340mm c/c	-	8 dia@ 150 mm c/c
Mid Span	8ø @ 320mm c/c	-	8 dia@ 150 mm c/c
Longer Span			
Support	8ø @ 380mm c/c	-	8 dia@ 150 mm c/c
Mid Span	8ø @ 270mm c/c	-	8 dia@ 150 mm c/c

3. Check for deflection

Allowable span / depth Ratio	I/D	=	32
% of Tension reinforcement	pt	=	0.179
Corresponding Compression reinf.	Bar dia	=	8mm
	spacing	=	150mm
% of compression reinforcement	pc	=	0.179

Modification factor for Tension reinf.	F1	=	1.20	(From Fig 4 in IS 456 – 2000)
Modification factor for comp.reinf.	F2	=	1.00	(From Fig 5 in IS 456 – 2000)

Modified span/ depth ratio	=	I/d xF1 xF2
	=	32 x 1.20 x 1.00
	=	38.40
Actual span / depth ratio	=	2970 / 126
	=	23.57

Actual span / depth ratio < Modified span /depth ratio 23.57 < 38.40

HENCE SAFE & SOUND

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DESIGN OF BEAM

Data:

Effective length		=	5.11 m
		=	5110 mm
Breadth of Beam		=	230 mm
Overall depth (assumed)		=	450 mm
Characteristic strength of steel			
	fy	=	500 N/mm^2
	fck	=	20 N/mm^2
	Cover	=	25 mm

Total Load

Dead load from slab		=	3.75 kN/mm^2
Ceiling Plastering		=	0.25kN/m^2
Floor finish		=	1 kN/mm^2
Total dead load		=	5.00 kN/m^2
Live load		=	2 kN/m^2
	Total Load	=	7.00 kN/m^2

Effective Depth = d = 450 - 25 - 25 / 2

= 412.5 mm

Distance of centroid of Compression reinforcement from the extreme compression fibre =

d' = 25 +(25/2)

= 37.5 mm

$\frac{d'}{d} = \frac{37.5}{412.5}$

= 0.09

Minimum Reinforcement

The min.area of tension reinforcement shall not be less than the given,

$$\frac{As}{bd} = \frac{0.85}{fy}$$

Where,

As	=	Min.area of tension reinforcement
b	=	Breadth of the beam or breadth of web of T-beam
d	=	Effective depth

fy = Characteristic strength of reinforcement

$$As = \frac{0.85 \times b \times d}{fy}$$

$$= \frac{0.85 \times 230 \times 412.5}{500}$$

= 161.29 mm2

Refering Design Aids IS:456,The reinforcement as shown in the sketch

Overall depth of beam = $\frac{1}{12}$ to $\frac{1}{20}$ of the span

Provide over all depth =450 mm

Width of rib =$\frac{2}{3}$ (depth of rib) = $\frac{2}{3}$(450-150)

=200 mm

Loading on the beam

From the Slab = $\frac{Wl_x}{6}\left[3 - \left(\frac{lx}{ly}\right)^2\right]$

= $\frac{7 \times 3.2}{6}\left[3 - \left(\frac{3.2}{5.11}\right)^2\right]$

=9.74 kN/m

D.L of the rib = 0.23 x 0.3 x 25 kN/m

= 1.8 kN/m

Total = 11.54 kN/m

Providing 16 mm dia bars at clear cover 25 mm

Effective cover = 25 + 8

= 33 mm

Effective depth d = 417 mm

Center to center bearing= 5.11 m

Effective span = 5.11 m

Max. BM = $\frac{11.54 \times 3.2 \times 3.2}{8}$

= 14.77 kN.m

Req.depth d = $\left\{\frac{1.5 \times 14.77 \times 10 \text{ ^ } 6}{2.75 \times 230}\right\}^{1/2}$

= 187.16 mm

Provided depth, D = 450 mm

$\frac{Mu}{bd^2}$ = $\left\{\frac{1.5 \times 14.77 \times 10 \text{ ^ } 6}{230 \times 417 \times 417}\right\}^{1/2}$

= 0.75

pt = $\frac{fck}{2 \times fy}\left(1-\left(SQRT\left(1-\frac{4 \times (Mu/b \times d^2)}{0.87 \times fck}\right)\right)\right) \times 100$

= 0.18 %

$$Ast = \left\{ \frac{0.18 \times 230 \times 417}{100} \right\}$$

$$= 2884 \text{ mm}^2$$

Provided 6 – Y16

Check for Shear

$$V = \frac{1.5 \times 11.54 \times 5.11}{2}$$

$$= 44.22 \text{ kN}$$

$$T_c = 0.54 \text{ N/mm}^2$$

$$V_{uc} = \frac{0.48 \times 230 \times 417}{1000}$$

$$= 46.1 \text{ kN}$$

V_{uc} > Shear at support

Provide Y8 @ 150 c / c (stirrups)

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$$As = \frac{p \times b \times D}{100}$$

$$= \frac{1.6 \times 230 \times 600}{100}$$

$$= 2208 \text{ mm}^2$$

Provide 12 – Y16 bars.

Design of Lateral Ties

Dia of lateral ties = $\frac{1}{4} \times 16 = 4$ mm

Hence 8mm dia bar is adopted

Pitch is min. of the following – (as per IS: 456)

a. Least lateral dimension = 300 mm
b. 16 x dia of bar
c. 300 mm

Hence provide Y8 @ 150mm c/c
Similarly other columns are calculated.

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DESIGN OF FOUNDATION

Design of Isolated footing for Intermediate column

Data :

Column Size	L	=	230 mm
	B	=	600 mm
Size of footing	L	=	2.5 m
	B	=	2.5 m
Safe Bearing capacity of soil	SBC	=	450 kN/m^2
Depth of footing below GL		=	2 m
Density of soil	g	=	18 kN/m^3
Characteristic strength of concrete	fck	=	20 N/mm^2
Characteristic strength of Steel	fy	=	500 N/mm^2
Depth of footing provided	D	=	1.2m
Cover	d'	=	50mm

1. Loading on footing

Axial load on column		=	2595 kN
Self weight of footing (10%)		=	131 kN
Total load on footing		=	2726 kN
Adpot size of footing		=	2.5 x 2.5 m
		=	6.25 m^2
Soil pressure	$\frac{P}{A}$	=	$\frac{2726}{6.25}$
		=	436 kN/m^2
Gross safe bearing capacity		=	450 kN/m^2

Hence safe & sound

2. Moment Calculation

Face of the column		=	$\frac{2.5 - 0.60}{2}$
		=	0.95 m
Design pressure		=	436 kN/m^2
Moment	M	=	$\left\{ \frac{436 \times (0.95)^2}{2} \right\}$
		=	196.75 kN.m
Factored moment		=	295.12 kN.m

3. Area of Reinforcement

Effective Depth	d	=	620 mm	(or)	0.62 m
Dia of bar provided	ø	=	20 mm		

Provided spacing = 100mm

$$\frac{Mu}{b \times d^2} = \frac{295.12 \times 10^6}{1000 \times 620 \times 620}$$

$$= 0.77$$

Percentage of tension reinforcement

$$pt = \frac{fck}{2 \times fy}\left\{1-\left(SQRT\left[1 - \frac{4 \times (Mu/b \times d2)}{0.87 \times fck}\right]\right)\right\} \times 100$$

$$= 0.51\ \%$$

Required, Ast $= \frac{0.51 \times 1000 \times 620}{100}$

$$= 3162\ mm^2$$

Hence safe & sound

4.Check for One way shear

Vu = 1.5 x 254 x 3 x 0.5 x 0.30 x 0.5 – 0.62

= 160 kN

Permissible shear stress $= \frac{160 \times 1000}{1000 \times 620}$

$= 0.26\ N/mm^2$

Allowable shear stress = $0.49\ N/mm^2$

Hence safe & sound

5.Check for punching shear

Punching force Pf $= \left(254 \times 608 - ((0.23 + 0.62) \times (0.60 + 0.62))\right) \times 1.5$

= 2187 kN

Punching shear stress $= \frac{2,187 \times 1000}{620 \times 2 \times (230 + 6000 + (2 \times 620))}$

$= 0.85\ N/mm^2$

Allowable shear stress = $1.25\ N/mm^2$

Hence safe & sound

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EARTH QUAKE ANALYSIS

1. Calculation of horizontal seismic Coefficient

As per IS 1893 – 2002

$$Ah = \frac{z \times 1 \times Sa}{2 \times R \times g}$$

Zone factor	Z	=	0.16	(As per table 7)
Importance factor	I	=	1	
Response reduction factor,	R	=	5	

$$\frac{Sa}{g} = 2.5$$

Natural period, Ta = $0.075\ h^{3/4}$

(Clause 7.6) h = height of the building

$= 0.075 \times 13.1^{0.75}$

$= 0.52$ sec

$$Ah = \frac{0.16 \times 1 \times 2.5}{2 \times 5}$$

$= 0.04$

2. Calculation of Base shear & seismic forces

Base shear V = $Ah \sum Wi$

$= 0.040 \times 1316$

$= 52.64$ kN

Total no of columns = 21

Shear per column = $\frac{25.64}{21}$

Seismic moment per column = $\frac{1.22 \times 3}{4}$

$= 0.92$ T-m

Column provided = 230 x 600 mm with 12 –Y16

Hence safe & sound

3. Checking for footing

SBC = 45 T/m²

Soil pressure = 25.4 T/m²

$$\frac{P}{A} \pm \frac{1.40 \times 6}{12}$$

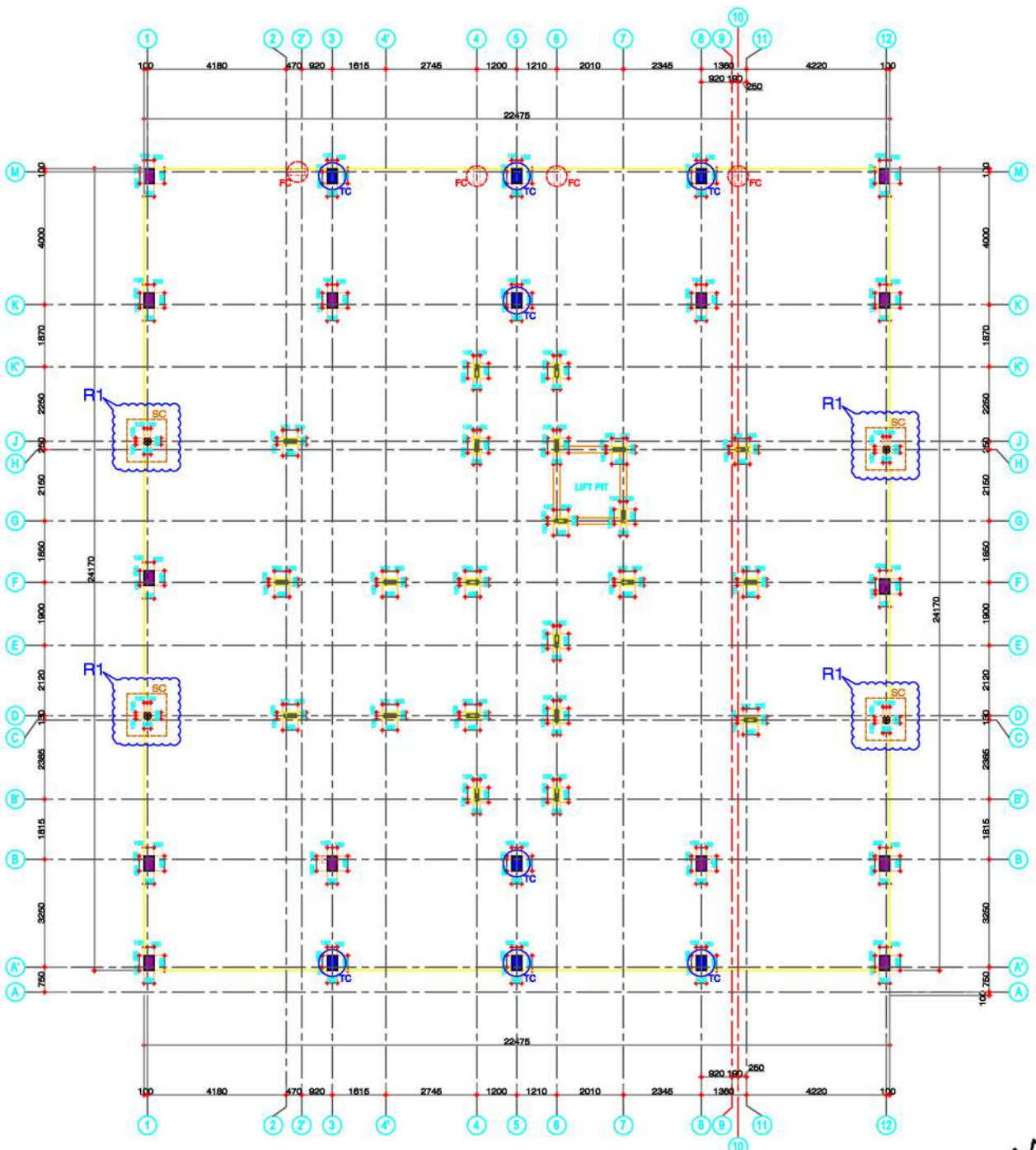
$= 25.4 \pm 0.7$

$= 26.1$

$= 24.7$ T/m² < 45.00 T/m²

Hence safe & sound

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STRUCTURAL DETAILS

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