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,	=	2.97	m
Eff.Longer Span		Lt		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				kN/m²
Weathering Course (Weight Not Applicable)		=	0.00	kN/m'
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

oNx	=	0.086
oPx	=	0.065
oNy	=	0.047
oPy	=	0.035

Shorter Span

Negative Moment (support) Mnx = Nx X Wux L,² = 0.086 x 10.50 x2.97² = 7.97kN.m

Positive Moment (Mid Span) Mpx = ai xW, x L ² = 0.065 x 10.50 x 2.97² = 6.02kN.m

Longer Span:

Negative Moment (Support) MNy = Ny X Wu x Ly² = 0.047 x 10.50 x 2.97² = 4.35kN.m

Positive Moment (Mid span) Mpy = aft x Wu x L ² = 0.035 x 10.50 x 2.97² = 3.24kN.m

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Reinforcement :

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

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

Ast in Shorter Span

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

Ast in Longer Span

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

	Reinf Required	Reinf Provided
Shorter Span		
Support	8B @ 340mm c/c	8 dia@ 150 mm c/c
Mid Span	8a @ 320mm c/c	g diap iso mm c/c
Longer Span		
Support	8s @ 380mm c/c	8 dia@ 150 mm c/c
Mid Span	8a @ 270mm c/c	8 dia@ 150 mm c/c

3. Check for deflection

Allowable span / depth Ratio — l/D = 32

32

% of Tension reinforcement — Pt = 0.179

Corresponding Compression reinf.

Bar dia = 8mmd

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

l/d xF1 xF2

= 32x1.20x1.00

= 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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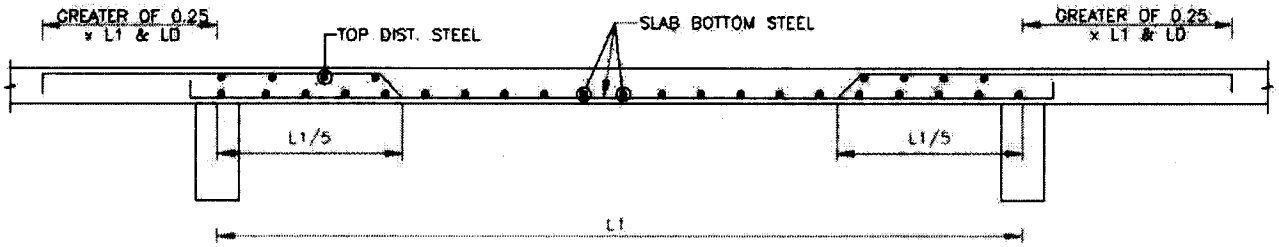
SCHEDULE OF FLOOR SLAB							
NO.	SLAB	SLAB TYPE	THICKNESS	BOTTOM REINFORCEMENT		EXTRA REINFORCEMENT	
				IN SHORTER DIR.	IN LONGER DIR.	IN SHORTER DIR.	IN LONGER DIR.
1.	S1	REGULAR	5"	10ø @ 6"C/C	8ø@ 6"C/C	10ø @ 6"C/C	8ø@ 6"C/C



TYPICAL SECTION
SHOWING SLAB REINFORCEMENT

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DESIGN OF BEAM

Data:

Effective length		= 5.11 m
		= 5110 mm
Breadth of Beam		= 230 mm
Overall depth (assumed)		= 350 *mm*
Characteristic strength of steel		
	fy	= 500 N/mm²
	fck	= 20 N/mm²
	Cover	= 25 mm

Total Load

Dead load from slab		=3.75 kN/mm²
Ceiling Plastering		=0.25kN/m²
Floor finish		=1kN/mm²
Total dead load		=5.00 kN/m²
Live load		=1kN/m²
Total Load	=	7.00 kN/m²

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)

= 37.5mm

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

= 0.09

Minimum Reinforcement

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

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

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

fy

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

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= 101.29 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 = 350 mm

Width of rib = 2 (depth of rib) = 2(350-150)

3 3

= 200 mm

Loading on the beam

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

$= \frac{7x3.2}{6}\left[3 - \left(\frac{3.2}{\quad}\right)^2\right]$

=9.74 kN/m

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

= 1.8 kN/m

Total = 8.54 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 $\frac{11.54 \times 3.2 \times 3.2}{8}$

= 10.77 kN.m

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

= 187.16 mm

Provided depth, D = 450 mm

$\frac{Mu}{bd^2} = \left\{\frac{1.5 \times 14.77 \times 10 \wedge 6}{230x417x417}\right\}^2$

= 0.75

pt2 x fy $= \frac{fck}{2 \times fy}\left(1 - \left(SQRT\left(1 - \frac{4 \times (Mu/b \times d^2)}{0.87 \times fck}\right)\right)\right)$ X 100

=0.18%

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

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

Provided 6— Y12

Check for Shear

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

$$= 32.22 \text{ kN}$$

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

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

$$= 46.1 \text{ kN}$$

Vuc > Shear at support

Provide Y8 @ 150 c / c (stirrups)

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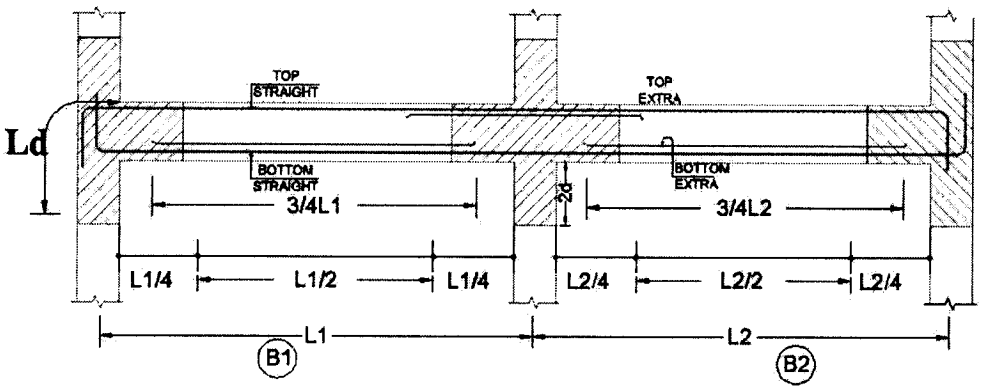
SCHEDULE OF ROOF BEAM						
NAME	SIZE	REINFORCEMENT: MAIN BAR		EXTRA REINFORCEMENT		SHEAR REINFORCEMENT
		TOP	BOTTOM	TOP	BOTTOM	
RB1	8"X12"	2-10Ø	2-10Ø	1-10Ø	1-10Ø	8Ø @ 6" C/C
RB2	8"X12"	2-12Ø	2-12Ø	1-12Ø	1-12Ø	8Ø @ 6" C/C



TYPICAL ARRANGEMENT OF BEAM REINFORCEMENT

SHEAR REIN. UNLESS OTHERWISE STATED

I.) SHEAR REIN. FOR ALL THE BEAMS SHALL BE 8mm @ 4" C/C IN L/4

II.) SHEAR REIN. FOR ALL THE BEAMS SHALL BE 8mm @ 6" C/C IN L/2

DUCTILE DETAILING FOR COLUMN AND BEAM JUNCTION IS SHOWN IN HATCHED AREA

SHEAR REINFORCEMENT IN HATCHED AREA @ d/4 mm c/c,(MINIMUM. 4" C/C)

WHERE ' d ' is the Effective Depth of the Beam.

NOTE :-

THE SHEAR REIN. IN L/4 SHOULD BE AS I.) OR D/4 mm C/C
WHICH EVER IS LESS FOR REST OF THE BEAM
PROVIDE SHEAR REIN. AS IN II.)

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DESIGN OF COLUMN

Data:

Total No. of floors			= 2
Total No. of Roof			= 2
Storey height			= 3 m
Breadth of column	b		= 230 m
			= 0.23 m
Depth of column	D		= 300 mm
			= 0.30 m
	fck		= 20 N/mm^2

Total axial load

Dead load & live load from one floor		=	280 kN
Total axial load all floors		=	2 x 280
		=	540 kN
Column dimension		=	230 x 600 mm
Self weight of column			0.23 x 0.30 x 2 x 20 x 3
		=	8 kN
Total load			(540 + 8.28) x 1.5
	Pu	=	818.28 kN

Area of Reinforcement

$\frac{d'}{D}$ = 0.80

d' = 50 *mm*

$\frac{Pu}{fck \times b \times D} = \frac{818.28 \times 10^3}{20 \times 230 \times 300}$

= 0.95

$\frac{Mu}{fck \times b \times D2} = \frac{1.S \times 30.48 \times 10^6}{20 \times 230 \times 600^2}$

= 0.02

Refering to chart in SP : 16 for values

$\frac{Pu}{fck.b.D}$ 0.95 $\frac{Mu}{fck.b.D^2}$ = 0.02

The value of $\frac{P}{fck}$ 0.05

P 0.05 x

= 1.0

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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 6 — Y12 bars.

Design of Lateral Ties

Dia of lateral ties = $\frac{1}{4} \times 12 = 4$ mm

Hence 8mm dia bar is adopted

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

a. Least lateral dimension = 300 mm
b. 12 x dia of bar
c. 300 mm

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

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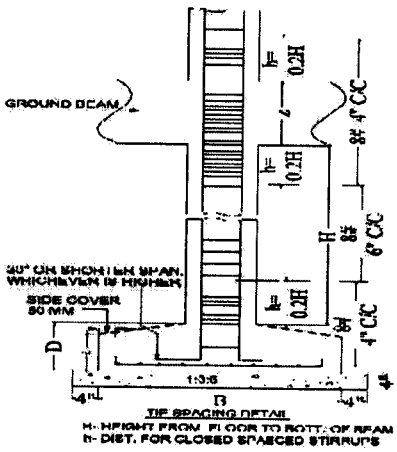

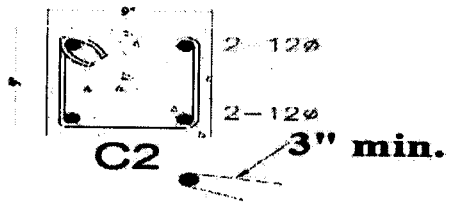

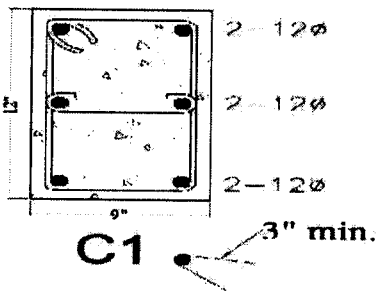

COLUMN DETAILS

S.NO	COLUMN NO.	SIZE	REINFORCEMENT	STIRRUPS	STIRRUPS AT JOINT
1	C1	9" x 12"	4-12ø	8 MM @4"C/C	8 MM @4"C/C
2	C2	9" x 9"	4-12ø	8 MM @4"C/C	8 MM @4"C/C

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DESIGN OF FOUNDATION

Design of Isolated footing for Intermediate column

Data :

Column Size	L		230 mm
	B		300 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

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 $\frac{436 \times (0.95)^2}{2}$

196.75 kN.m

Factored moment 295.12 kN.m

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3. Area of Reinforcement

Effective Depth	d	620mm	(or)	0.62 m
Dia of bar provided	e	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

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

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 $\frac{zx1xSa}{2 \times R \times g}$

Zone factor	Z	=	0.16	
Importance factor	I		1	(As per table 7)
Response reduction factor,	R	=	5	
	Sa / a		2.5	

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

(Clause 7.6) h = height of the building

$= 0.075 \times 13.1^{0.7\wedge}$

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 = Aha 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 = 35T/m^2

Soil pressure = 25.4T/m^2

$$\frac{P}{A} \quad 1 \quad \frac{1.40 \times 6}{12}$$

$$25.4 \quad z \quad 0.7$$

$$26.1$$

$= 15.7\ \text{T/m}^2 \quad < 25.00\ \text{T/m}^2$

Hence safe & sound

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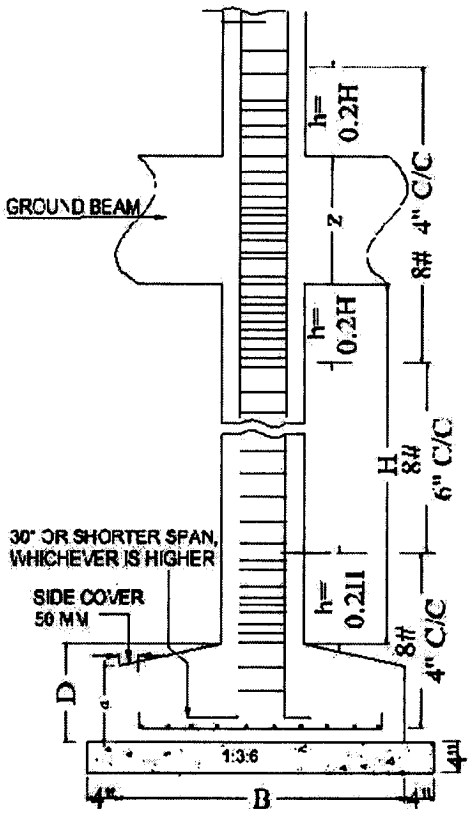
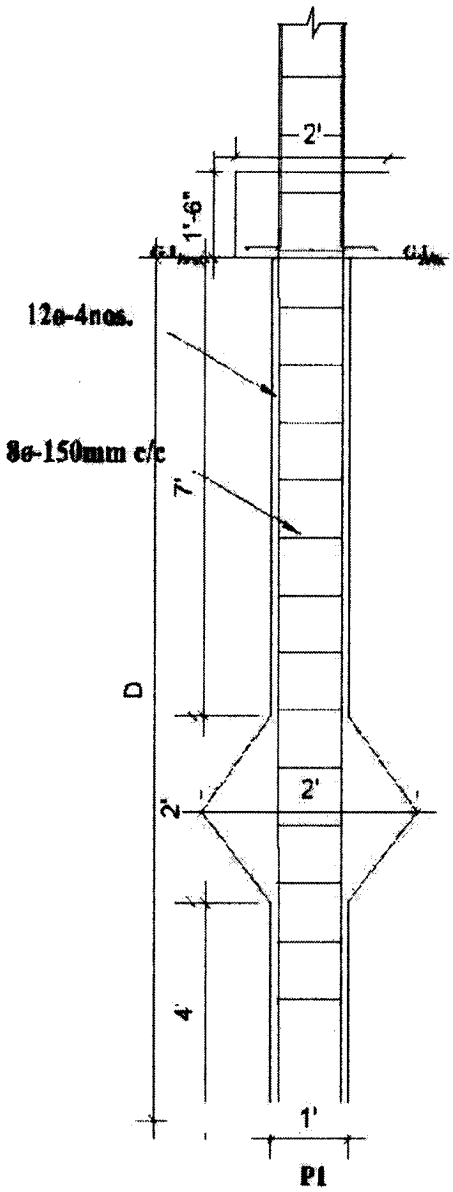


TIE SPACING DETAIL

H- HEIGHT FROM FLOOR TO BOTT. OF BEAM

F- D ST. FOR CLOSED SPACED STIRRUPS



FOOTING SCHEDULE

S. NO.	FOOTING NO.	SIZE			THICKNESS	DEPTH	REINFORCEMENT (PILE CAP)	COVER	NO.OF BARS
		F. DIA.	DIM.	PCC	T	D	Rx - Ry	BOTH DIRECTION	PILE
1	P1	12'Ø	4'0"X4'0"	2'3"X2'6"	18"	15"	12 Ø @ 6" C/C	2"	4 - 12Ø

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