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P. SENTHIL KUMAR M.E., (Struct), AIV
Chartered Engineer | Structural Consultant
Registered Valuer

THE DESIGN ONE
Civil and Structural Engineering Consultancy

STABILITY CERTIFICATE

1. The detailed engineering and structure design of the proposed building comprising of Stilt +5 floors at Thudaiyalur Village, Coimbatore North taluk S.No:557/1B2B, 557/1B3B &557/1B4B, WARD NO. : 15, GANESH NAGAR EXTENSION,GANDHI NAGAR, GOUNDER MILL POST, THUDIYALURVILLAGE, COIMBATORE DISTRICT, has been done by me/us based on the report of geotechnical investigation (soil test) done by GEODESIGN INDIA PRIVATE LIMITED and considering the functional requirement of the Building.

2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building would be safe.

3. I/We further certify that:

(i) The minimum grade of concrete is M20

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No IS 456-2000 & IS 875-1987.

4. The building will be **SAFE AND SOUND** when used for the purpose for which it is Designed.

Thanks &with regards

P. Senthil Kumar
Structural Consultant

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PROJECT	DAC DEVELOPERS - THULIR APARTMENT @ COIMBATORE
CONSULTANT	THE DESIGN ONE
DESIGN OF BEAM	RB112

DESIGN DATA:

Breadth of the beam, b	=	200 mm	=	0.2 m	
Effective depth of the beam, d	=	417 mm	=	0.417 m	
Width of the supports	=	200 mm	=	0.2 m	
Grade of concrete, f_{ck}	=	25 N/mm^2			
Grade of concrete, f_y	=	500 N/mm^2			
Moment of Resistance, M	=	100 kNm			
Uniformly Distributed Load, W	=	23 kN/m			
Length of the beam,L	=	4.4 m	=	4400 mm	

PRELIMINARY DIMENSIONS OF THE BEAM:

Assume effective cover of the beam,c'	=	33 mm	=	0.033 m	
Therefore,overall depth of the beam, D	=	450 mm	=	0.45 m	
a)Effective Span, L_{eff}	=	L+d	=	4.8 m	
b)Effective Span, L_{eff}	=	L+W	=	4.6 m	
Therefore, adopt Effective Span, L_{eff}	=	*4.6 m (minimum)*			

ULTIMATE MOMENTS:

$x_{u\,lim}/d$	=	0.48	33
Therefore, $x_{u\,lim}$	=	200.16 mm	
M_u'	=	$0.36*f_{ck}*b*x_u*(d-0.42x_u)$	
	=	119951693 Nmm	
	=	119.951693 kNm	
Ultimate moment, M_u	=	1.5*M = 150 kNm	
M_u''	=	M_u-M_u'	
	=	30.0483074 kNm	
	=	30048307.4 Nmm	

TENSILE REINFORCEMENT:

From I.S. 456:2000, pg.no. 96, Annex-G,section G-1.1 a)

$x_{u\,lim}/d$	=	$(0.87*f_y*A_{st})/(0.36*f_{ck}*b*d)$	
Therefore, $A_{st\,1}$	=	828.248276 mm^2	
M_u''	=	$f_{sc}*A_{st\,2}*(d-d')$	
where d'	=	distance from top fibre to the centre of compression reinforcement.	
	=	50 mm	
Therefore, $A_{st\,2}$	=	188.219533 mm^2	
Total A_{st}	=	1016.46781 mm^2	
Assume		16 mm dia bars.	
	a_{st} =	200.96 mm^2	
Number of bars, n	=	5.05806035 = 5 Nos.	
Spacing	=	40 mm	
Therefore adopt		**5 nos. of 16 mm dia bars @ 40 mm c/c. in tension zone.**	
$A_{st\,provided}$	=	1607.68 mm^2	

COMPRESSION REINFORCEMENT:

$A_{st\,2}$ =	$(A_{sc}*f_{sc})/(0.87*f_y)$	(In pg.no. 56 in R.C.C. book)	
ϵ_{sc} =	$0.0035*((x_u-d')/x)$	By interpolating:	
f_{sc} =	353.725 N/mm^2	ϵ_{sc}	f_{sc}
A_{sc} =	231.466526 mm^2	0.00276	351.8
Assume	16 mm dia bars.	0.00298	353.725

a_{st} = 200.96 mm^2 0.0038 360.9

Number of bars, n = 1.15180397 = 2 Nos.

Spacing = 100 = 100 mm

Therefore adopt **2 nos. of 16 mm dia bars @ 100 mm c/c. in compression zone.**

$A_{sc\ provided}$ = 401.92 mm^2

CHECK FOR SHEAR:

From I.S. 456:2000, pg.no. 96, Annex-B-5.1)

Nominal shear stress, τ_v = v_u/bd

where shear force ,v_u = 75.9 kN

= 75900 N

τ_v = 0.43 N/mm^2

% of tensile reinforcement, p_t = 1.92767386

FROM IS 456:2000 pg.no.:73 table 19:

p_t	τ_c
1.75	0.49
1.927673861	0.50421391
2	0.51

Design shear stress, τ_c = 0.50421391 N/mm^2

$\tau_v > \tau_c$ **hence safe**

Hence provide shear reinforcement

V_{us} = $v_u - \tau_c bd$

= 33848.56 N

= 33.84856 kN

Use 2 legged 8 mm dia bars

A_{sv} = 100.48 mm^2

S_v = $(0.87 * f_y * Asv * d)/v_{us}$

= 538.474003 mm

= 530 mm

S_v > 0.75d

= 312.75 mm

Adopt 2 legged 8 mm dia bars @ 530 mm c/c near the support & 350 mm c/c at mid-span.

CHECK FOR DEFLECTION:

$(l/d)_{act}$ = 10.5515588

$(l/d)_{max}$ = $(l/d)_{basic} * k_t * k_c * k_f$

p_t = 1.92767386

p_c = 0.48191847

Refering the diagram,

k_t = 0.93

k_c = 1.1

k_f = 1

Therefore, $(l/d)_{max}$ = 20.46

Hence safe against deflection

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PROJECT	DAC DEVELOPERS - THULIR APARTMENT @ COIMBATORE
CONSULTANT	THE DESIGN ONE
DESIGN OF COLUMN	C4

DESIGN DATA:

Axial Load, P	=	1400 kN
Breadth of the column, b	=	200 mm
	=	0.2 m
Depth of the column, D	=	600 mm
	=	0.6 m
Unsupported length of the column in x-x axis, L_x	=	3 m
Unsupported length of the column in y-y axis, L_y	=	3 m
Bending Moment about x-x axis, M_x	=	16.853 kNm
Bending Moment about y-y axis, M_y	=	23.83 kNm
Effective length factor	=	0.85
Grade of concrete, f_{ck}	=	25 N/mm^2
Grade of steel, f_y	=	500 N/mm^2

EFFECTIVE LENGTH:

Effective length of the column in x-x axis, L_{ex}	=	2.55 m
	=	2550 mm
Effective length of the column in y-y axis, L_{ey}	=	2.55 m
	=	2550 mm

CHECK FOR SLENDERNESS RATIO:

L_{ex}/D	=	4.25
	<12	

Hence, short column

L_{ey}/b	=	12.75
	>12	

Hence, long column

CHECK FOR MINIMUM ECCENTRIES:

$e_{ex, min}$	=	$(L_{ex}/500)+(D/30)$
	=	25.1 mm
	OR	20 mm
$e_{ey, min}$	=	$(L_{ey}/500)+(b/30)$
	=	11.766667 mm
	OR	20 mm
Factored Bending moment in x-x axis, M_{ux}	=	25.2795 kNm
Factored Bending moment in y-y axis, M_{uy}	=	35.745 kNm
Factored Load, P_u	=	2100 kN
	=	2100000 N
M_{ux}/P_u	=	12.037857 mm
	<20	mm
M_{uy}/P_u	=	17.021429 mm
	<20	mm

Hence, design for uniaxial moment

LONGITUDINAL REINFORCEMENT:

Hence, Factored Bending Moment, M_u	=	35.745 kNm
	=	35745000 Nmm

Governing Axis for Bending is y-y axis

$M_u/f_{ck}bD^2$	=	0.059575	
	=	0.06	
$P_u/f_{ck}bD$	=	0.7	
	=	0.7	
Effective cover, d'	=	60 mm	
Therefore, d'/D	=	0.3	
	=	0.3	
From Interaction chart of SP 16			
p/f$_{ck}$	=	0.12	
p	=	3 %	
0.8%<p<4%			
Hence O.K.			
A_s	=	3600 mm^2	
Assume		20 mm dia bars	
No. of bars, N	=	11.464968	
	=	12 Nos.	
$A_{s\ provided}$	=	3768 mm^2	
Actual p	=	3.14 %	
0.8%<p<4%			
Hence O.K.			
Hence, provide	***12 #***		***20 mm dia***
bars uniformly distributed on four sides			

LATERAL REINFORCEMENT:

Diameter of Lateral Ties:

Dia of Lateral Ties	=	5 mm	(OR)
Dia of Longitudinal rft./4	=	5 mm	
Whichever is lesser			
Therefore Dia of lateral ties	=	5 mm	
	=	8 mm	

Spacing:

Least lateral dimension of the column	=	200 mm
16*Dia of the longitudinal bar	=	320 mm
	=	300 mm
Whichever is lesser		
Required Spacing	=	200 mm
Therefore, adopt	***8 mm dia lateral ties @ 200 mm c/c***	

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PROJECT	DAC DEVELOPERS - THULIR APARTMENT @ COIMBATORE
CONSULTANT	THE DESIGN ONE
DESIGN OF FOOTING	C4

DESIGN DATAS:

Column transfer load, P	=	1400 kN		
	=	1400000 N		
Breadth of the column on footing, b	=	200 mm	=	0.2 m
Depth of the column on footing, D	=	600 mm	=	0.6 m
Grade of concrete, f_{ck}	=	25 N/mm^2		
Grade of steel, f_y	=	500 N/mm^2		
Safe Bearing Capacity of Soil, SBC	=	295 kN/m^2		

SIZE OF FOOTING:

Factored Load, P_u	=	2100 kN		
	=	2100000 N		
Self-weight of footing	=	140 kN		
Total load on footing	=	1540 kN		
	=	1540000 N		
Area of footing	=	Total load on footing/SBC		
	=	5.22033898 m^2		
Size of footing	=	2.28480611 m		
		2.29 m		
Length of the footing	=	2.29 m	=	2290 mm
Breadth of the footing	=	2.29 m	=	2290 mm
Provided area of footing	=	5.2441 m^2		
Ultimate soil pressure, W_u	=	400.45003 kN/m^2		

Hence, size of footing is correct.

BENDING MOMENT:

Cantilever portion, l'	=	0.845 m		
Bending Moment	=	$W_u l'^2/2$		
	=	142.965666 kNm		
	=	142965666 Nmm		

DEPTH OF FOOTING:

Assuming the given section as balanced section,

$M_{u\,lim}$	=	$0.138*f_{ck}*b*d^2$		
Keep length of the footing	=	1000 mm		
Effective depth, d	=	203.566509 mm		
Hence provide,d=		550 mm depth of footing		
		0.55 m depth of the footing		
Keep minimum cover, c'	=	50 mm		
Overall depth, D	=	600 mm		

AREA OF TENSILE REINFORCEMENT:

M_u	=	$0.87*f_y*A_{st}*d*(1-((f_y*A_{st})/(b*d*f_{ck})))$		
By Quadratic Equation A	=	$f_y/(b*d*f_{ck})$	=	4E-05
B	=	-1		
C	=	$M_u/(0.87*f_y*d)$	=	597.6
$A_{st\,1}$	=	$(-B+sqrt(B^2-4AC)/2B$	=	26889 mm^2

$A_{st\,2}$ = (-B-sqrt(B^2-4AC)/2B = 611.1 mm^2

Required A_{st} = 611.139136 mm^2

Minimum A_{st} = 0.12%*gross area of footing

= 660 mm^2

Hence, adopt A_{st} = 660 mm^2

Assume 12 mm dia bars

a_{st} = 113.04 mm^2

No. of bars = 5.40639717 Nos.

= 6 Nos.

Spacing = 166.666667 mm

Provide 12 mm dia bars @ 167 mm c/c.

$A_{st\ provided}$ = 678.24 mm^2

% of tensile reinforcement, p_t = $(100*A_{st\ provided})/(b*d)$

= 0.12331636 %

CHECK FOR ONE-WAY SHEAR:

Nominal shear stress, τ_v = V_u/bd

V_u = $W_u*((L/2)-(b/2)-d)$

= 118.132759 kN

= 118132.759 N

Nominal shear stress, τ_v = 0.21478683 N/mm^2

Permissible shear stress, τ_c' = $k*\tau_c$

k = 1

(From I.S. 456-2000, pg.no.: 72, clause 40.2.1)

Interpolation from I.S. 456-2000

τ_c (for f_{ck}=25 N/mm^2)	$(100*A_{st\ provided})/(b*d)$
0.29	0.15
0.271321455	0.123
0.36	0.25

τ_c = 0.27132145

Permissible Shear stress, τ_c' = 0.27132145 N/mm^2

Hence safe agaist one-way shear

CHECK FOR TWO-WAY SHEAR:

Nominal shear stress, τ_v = $V_{uB}/b_o d$

VuB = $W_u*(L_xL_y-(b+d)(D+d))$

= 1754.61185 kN

= 1754611.85 N

b_o = 2(b+d)+2(D+d)

= 3800 mm

Nominal shear stress, τ_v = 0.8395272 N/mm^2

Permissible Shear stress, τ_c' = $k_s*\tau_c$

τ_c = $0.25*sqrt(f_{ck})$

= 1.25 N/mm^2

k_s = $0.5+\beta_s$

β_s = (Shortdimension/Long dimension) of column

= 0.33333333

k_s = 0.83333333 <1

= 1

Permissible Shear stress, τ_c' = 1.25 N/mm^2

Hence safe against two-way shear

CHECK FOR DEVELOPMENT LENGTH:

From I.S. 456-2000, Clause 26.2.1 :

Development Length, L_d = $(\Phi\sigma_s)/(4\tau_{bd})$

= 679.6875 mm

Assume 60 mm side cover

Available Length = 1015 mm

Hence O.K.

CHECK FOR BEARING OR TRANSFER OF LOAD ON FOOTING:

Allowable stress, $f_{br\ all}$ = $0.45*f_{ck}*\text{sqrt}(A_1/A_2)$

where A_1 = Area of footing

A_2 = Area of column on footing

A_1 = 5244100 m^2

A_2 = 120000 m^2

$\text{sqrt}(A_1/A_2)$ = 6.61066058 >2

Therefore, keep $\text{sqrt}(A_1/A_2)$ = 2

Allowable stress, $f_{br\ all}$ = 22.5 N/mm^2

But actual stress, fbr act. = 17.5 N/mm^2

Hence safe against bearing

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