International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

Planning, Analysis and Designing of Cantilever Residential Building

M. Balachandran[1], A. Anthonisamy[2], V. Manikandan[3]

[1,2,3]Student, Department of Civil Engineering, Panimalar Engineering College, Tamil Nadu, India.

Abstract - The project is about planning, analysis and designing of cantilever residential building. It is a framed structure, the residential building is located near to ooty. The total area of building is 100.3 sq.m. The plan and reinforcement details drawn by using Auto-CADD. Analysis done by Manual Calculation. Design are worked by referring code books.

Key Words: Ground Floor size :100.35 sq.m, First Floor area :100.35 sq.m, No of Floors :G+1

1. INTRODUCTION

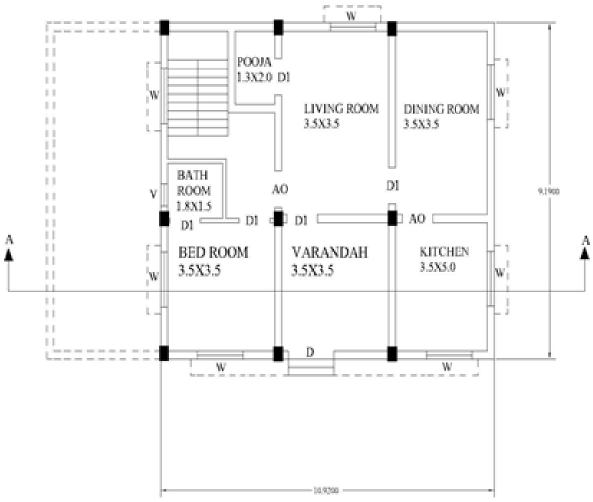
The basics needs of human existences are food, clothing and shelter. From times immemorial man has been making efforts in improving their standard of living. The point of his efforts has been to provide an economic and efficient shelter. Every human has an inherent like on a peaceful environment for his pleasant living this objective is achieved by having a place for living, situated at a safe and convenient location. Such a place for comfortable and pleasant living is required to all. Construction is the important aspects of civil engineering. Mankind has been evolving different kinds of environment with the change in civilization and time.

2. METHODOLOGY

- Plan of the Building
- Design of Cantilever Slab
- Design of Cantilever Beam
- Design of Column
- Design of Footing
- Design of Staircase
- Conclusion

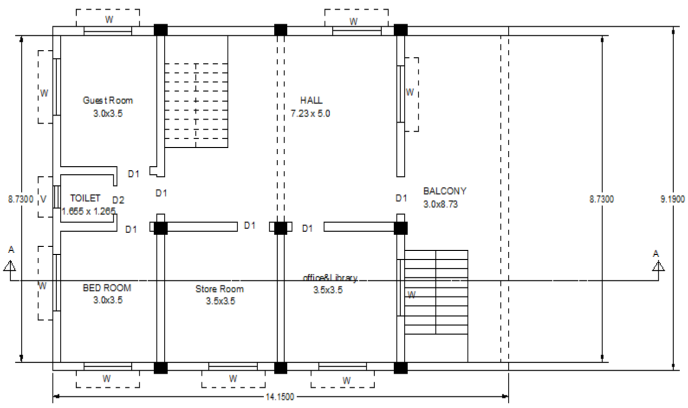
2.1 Plan of the building

Ground Floor Plan



ALL DIMENSION ARE IN m

First Floor Plan



ALL DIMENTIONS ARE IN m

2.2 Design of Cantilever Slab

Span = 3 m
Live Load = 3 KN/m^2
Floor Finish = 1 KN/m^2
M20 & Fe 415 grade

Calculation of Depth of Slab:

d = Span/7
= 3000/7

d = 428.57 mm = 460 mm
Over all Depth = Depth of Slab + Cover
Assume Cover = 20 mm
D = 480 mm

Load Calculation:

Self Weight of Slab = 0.2x25 = 5 KN/m
Floor Finish = 1 KN/m
Live Load = 3 KN/m
Total Load = 9 KN/m
Ultimate Load = 13.5 KN/m
Maximum Bending Moment,
Mu = Wu $l^2/2$
= 70.42 KN.m
Maximum Shear Force,
Vu = Wu l = 43.60 KN

Calculation of Limiting Moment of Resistance:

Mu limit = 0.138 fck bd^2
= 584.01 KNm
Mu < Mu limit
Hence it is Under Reinforced Section

Calculation of Area of Steel:

Mu = 0.87 fy Ast d (1 – fy Ast / fck bd)
70.42X10^6 = 0.87X415XAstX460 (1– 415Ast/20X1000X460
Ast = 432.43 mm^2

To Find Main Ast Provided:

No of bars = Ast / ast
Assume dia = 10 mm So ast = 78.53 mm^2
So No of bars = 6 Nos
Ast Provided = 6 X $\pi/4$ X 10^2
= 471.23 mm^2
Ast Req < Ast Pro
Hence Safe

Calculate Spacing of Steel:

Spacing = 1000 Ast Of 1 bar / Area of Steel
Area of 1 bar = $\pi/4$ x d^2
Assume dia = 10 mm = 78.53 mm^2
Spacing = 190 mm

Check for Spacing:

1) 300 mm
2) 3d = 3x460 = 1380 mm
3) 190 mm
Hence Provide 8 mm dia bars @ 190 mm c/c

Check Distribution Area of Steel:

= 0.12 % of gross area
= 552 mm^2

To Find Distribution Ast Provided:

No of bars = Ast / ast
Assume dia = 8 mm So ast = 50.26 mm^2
So No of bars = 12 Nos
Ast Provided = 12 X $\pi/4$ X 8^2
= 603.16 mm^2
Ast Req < Ast Pro
Hence Safe

Calculate Spacing of Steel:

Spacing = Area of one bar / Area of steel
= 90 mm

Check for Deflection:

(L/d)max > (L/d)pro
(L/d)max = B.V X Kt X Kc
= 9.59
(L/d)pro = Span / Eff depth
= 7.02
9.59 > 7.02
Hence Safe

2.3 Design of Cantilever Beam

To Find Over all Depth:

Length of cantilever = 3 m
M.F = 1
eff depth = span/7 x MF
= 3000/7 x 1
= 428 ~ 430 mm
effective cover = 25 mm
Overall depth of beam= 430 + 25
= 455 mm

To Find Effective Depth:

Provide an overall depth of 460 mm
Effective depth d = 460 – 25
= 435 mm

To Find Dead Load Moment:

Let the section of cantilever be,
230 mm x 435 mm at fixed end
2/3 x d = 2/3 x 435
= 290 mm
230 mm x 290 mm at free end
D.L of the cantilever = (0.435 + 0.29/2) x 0.23 x 3 x 25000
= 6253.13
Load acts at a distance = {(0.435 + 2 x 0.29)/ (0.435 + 0.29)} x 3/3
= 1.4 m from fixed end
D.L moment = 6253.13 x 1.4
= 8754.4 Nm

To Find Live Load Moment:
From Wall:

Live load = 3 x 0.23 x 2
= 13.8 KN/m
Total live load = 13.8 + 15.93
= 29.73 KN/m
Live load moment= wl2/2
= 29.73 x 32/2 = 133.78 KNm

To Find End Load Moment:

End point load = 2.5 + 1.75
= 4.25 x 0.35 x 25 = 37.18 KN/m
End load moment= W.L
= 37.18 x 3 = 111.56 KN/m
Total moment= E.M + L.L.M + D.L.M
= 111.56 + 133.78 + 8.75
= 254.09 KNm

To Find Limiting Moment:

Total load = (29.73 + 8.75) x 3 + 37.18
= 152.62 KN
Mu= 254.09 x 1.5
= 381.135 KNm
Mu limit = 2.76 bd2
= 2.76 x 230 x 4602 =134.32 KNm

To Find Area of Tension & Compression Reinforcement:

Percentage of steel required,
Pt= 25/460
= 0.05
Mu/bd2 = 381.135/0.23 x 0.462
= 6.35

Tension zone:

Ast = 2.002/100 x 230 x 4602
= 974.3 mm2
Asc = 1.091/100 x 230 x 4602
= 530.91 mm2

To Find No of Bars:

No of bars use 20 dia bars,
Use 4 Nos of 20 dia @ tension zone
No of bars at compression zone
Use 16 mm dia
No of bars = 530.91/ (π/4 x 162)
= 2.67 ~ 3 Nos

To Find Check for Shear:

τv = Vu/bd
Vu= (152.62 x 103)/230 x 460
= 1.53 N/mm2
τc= 100 Ast/bd
= (100 x 974.3) / (230 x 460)
= 0.597 N/mm2
$K\tau c$ = 1 x 0.59
= 0.59 N/mm2
$\tau cmax$ =2.8 N/mm2
$\tau v < K\tau c < \tau cmax$
Hence Safe

2.4 Design of Column

To Find Axial Load:

B = 300 mm
D = 400 mm
L = 3.5 m
Mu1 = $Wlx^2/12 = 27.68x3.5^2/12$ = 37.44 KNm
Mu2 = $Wlx^2/12 = 18.68x3^2/12$ = 14.01 KNm
Mu = Mu1 + Mu2 = 51.45 KNm
51.45 = $Wl^2/8 = Wu \times 6.5^2/8$
Wu = 9.74 KN/m
Pu = 9.74x6.5 = 63.32 KN

To Find Non-Dimensional Parameters:

d' = 40 mm
D = 400 mm
= 0.1
From chart – 32,
Mu/fck b D^2 = 51.45x10^6 / (20x300x400^2) = 0.05

Pu/fck b D = 63.32x10^3 / (20x300x400) = 0.026
P/fck = 0.2 , P = 4

To Find Reinforcement:

As = pbD/100 = 4x300x400/100 = 4800mm^2
Adopt 25 mm dia
n = 4800 / (π/4x25^2) = 8 Nos

To Provide Lateral Ties:
Condition:
Diameter:

5) ¼ x 25 = 6.25 = 6 mm
6) Less than 16 mm
Spacing:
7) LLD = 300 mm
8) 16x25 = 400 mm
9) 300 mm
Take Spacing minimum value
S = 300 mm

2.5 Design of Footing

To Find Loads:

Total load =383.91kN+[0.3x0.4x3x25]
=392.91kN
For 2 floor=2x392.91
P=785.82kN
Pu=785.82x1.5
=1177.73~1200Kn

To Find Area of Footing:

SBC=300kN/m^2
Area of footing =1200/300
=4m^2

To Find Size of Footing:

4x x 3x=4
x^2=0.33
x=0.577m
4x=4x0.577
=2.3m
3x=3x0.577=1.73~1.75m
Size of footing = 2.3x1.75m
Area =2.3 x1.75
=4.025 m^2

To Find Net Upward Soil Pressure:

Net upward soil pressure(q)
q=load on footing/A
=1200/4.025
q=298.13kN/ m^2<300kN/m^2

To Find Moment:

Factored moment (Mud)
Mmax occur at the face to the column for design purpose
Consider only one overhang portion,
Mud=1.5
[Upward soil pressure x hatched x distance between C.G for end and
Face to column]
=1.5[300 x (0.95x1.75) x 0.475]
=355kN.m

To Find Depth Upward for Moment:

Equate Mud to Mulimit
For M20 & Fe 415
From sp16 pg : 10, Table D
Mulimit=2.76 bd^2
355x10^6=2.76 x 1750 x d^2
d^2 =73573
d=271.24mm
D=271.24+50
D=321.24mm~400mm
d=400-50
=350mm
Mulimit=2.76x1750x3502
=591.67kN.m
Mulimit >Mud
It is under reinforced section

To Find Area of Main Reinforcement:

Mud=0.87 x fy x Ast x[d-fy x Ast / fck x b]
355 x 106=126367.5 Ast-4.28 Ast2
Ast=3144.09mm2

To Find Area of Distribution Reinforcement:

Astmin = 0.12% CSA
=0.12/100 x 350 x 1750
Astmin=735mm2

To Find Spacing:

Use 20 mm dia of bar
S=ast/Ast x 1000
= (π/4 x 202)/3144 x 1000
S=170 mm
Provide 20 mm dia bar @ 170 mm C/C in both direction

Check for Shear:
Check for One Way Shear:

Vu=1.5[q x hatched area]
=1.5[300 x 1.75 x 0.55]
Vu=433.12kN
Resisting area for shear =b x d
=1750 x 550
=962500 mm2
τv= Vu/bd
=433.12 x 103/1750 x 550
=0.38 N/mm2
Astp =ast/s x 1750
= (π/4 x 202)/170 x 1750
=3233.99~3234mm2
Pt = 100 Astp / bd
=100 x 3234 / (1750 x 550
Pt =0.336
τc=0.40
k=1
kτc=0.40
τv < k τc
0.38 < 0.40
Hence it is safe.

Check for Two Way Shear:
(Or)
Punching Shear:

Side length of critical plane =size of column + d/2 + d/2
Short side = 300 + 300/2 +300/2
=600mm
Long side = 400 + 400/2 + 400/2
= 800mm
Punching critical plane,
= 2(600) + (800)
=2800mm
Vu= q x hatched area x 1.5
= 300 x [(2.3 x 1.75) – (0.6 x 0.8)] x 1.5
Vu= 1595.25kN
τv= Vu / bd
=1595 x 103 / 2300 x 400
= 1.04 N /mm2

Permissible Shear Stress:

βc= short side / long side
= 300/400
βc= 0.75

2.6 Design of Staircase

Design size = 2x3m
Height of each flight =3/2= 1.5m
Assume =150mm(Rise) Tread = 300mm
Width of landing =400mm
M20 @ Fe250
No.of rise =(1500/150)=10
No. Of treads of each flight = no.of rise -1 =9
Assume width of landing = 400mm
Live load = 3KN/m

To Find Effective Span:

l_e=(9x300)+(400/2)+(400/2)+(230/2)
l_e=3.125m

To Find Depth of Waist Slab:

Depth of wist slab = (effctive span / 20)
= 3125/20 = 156.25mm~160mm
D = 160 mm

To Find Load Calculation:

DL of slab (on slope) =0.16x1x25=4KN/m
DL of slab on horizondal span = Ws$\sqrt{(R^2+T^2)}$/T
= 4$\sqrt{(0.15^2+0.3^2)}$/0.3=4.47KN/m
DL. of one step = (1/2)xrise xtread=(1/2)x0.15x0.3 =0.563 KN/m
Load of steps per m length = 0.563x1/(1000/300)
= 1.875 KN/m
Load due to floor finish = 0.6 KN /m
Total DL = 4.47+1.875+0.6+3 = 9.945 KN/m
Total ultimate load = 9.945x1.5=14.91KN/m

To Find Bending Moment:

Maximum bending moment @ center in ultimate BM
Mu = Wu x leff^2/8 = 14.91x3.125^2/8
= 18.20 KN/m

Check for Depth:

Mu = 0.149 xfck xbxd^2
= 0.149x15x1000x/d^2
d req = 90mm
d req <d pro

To Find Ast for Main Reinforcement:

Mu = 0.87xfyxAstxd((1-fyxAst)/(fckxbxd))
18.20x10^6= 29145Ast-3.62 Ast^2
Ast = 684.76 mm^2

To Find Spacing:

Use 12mm ϕ
Spacing = (1000xast /Ast)= 165.15mm ~170 mm
Provide 12mmϕ @spacing 170 mm c/c

To Distribution Reinforcement:

Ast min = 0.15%xbxD
= (0.15/100)x1000x160
Ast min = 240 mm^2
Spacing = (1000 ast / Ast)
= (1000x78.53/240)
Spacing = 300mm

3. CONCLUSION

At the end of the site visit and experiencing real workingspace and the environment of construction,I realized that working at construction site is much more different and also more difficult, because of the weather conditions and the risks exit.This site visit gave me a chance to experience and learn what cannot be gained during lectures or tutorials. One of the first things that I have learnt is understanding the importance of safety which is a basic of construction, because of all dangers exist on site.Finally, this site visit helped for better understanding what I am going to face in future as a Quantity surveyor, and also giving me better understanding about construction to help me in my studying, especially for taking off in measurement. In overall, it was a great experience for me.

REFERENCES

[1] IS 456-2000 Plain and reinforced concrete code
[2] SP 16 Design Aids for reinforced concrete
[3] IS 875 part-II Code of practice for design loads for buildings and structures
[4] Dr.P.Purushotama raj on "Design of reinforced concrete elements" by Lakshmi publications.

BIOGRAPHIES

Author 1: M.Balachandran
Studying B.E Civil
Panimalar Engineering College
Chennai.

Author 2: A.Anthonisamy
Studying B.E Civil
Panimalar Engineering College
Chennai.

Author 3: V.Manikandan
Studying B.E Civil
Panimalar Engineering College
Chennai.