“Analysis and Design of Proposed Girls Hostel in JIT Campus, Davanagere”

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Abstract - In today’s world, from civil engineering point of view, it is very important that the structures are properly analyzed, evaluated and estimated before they are implemented in the field. The present study deals with analysis and design of G+3 hostel building. The study has been carried out for (G+3) building by considering gravity load. The analysis of building has been done by using finite element software such as ETABS.

The study involves planning of hostel building with a capacity of 200 students and area of the each room has been allotted according to the HMO standards. The building comprising of total 72 numbers of rooms. The model of building has been done in ETABS. The material properties of concrete and steel has assigned according to the standards. The analysis has been carried out in the software. The obtained results from the ETABS are taken separately. For the design, the spread sheets have been prepared according to the Bureau of Indian standard (IS 456-2000 and SP-16). The each structural element such as slabs, beams, columns and footings have been designed according to the code books. These results will also be compared with manual calculations of a sample beam and column of the same structure designed as per IS 456-2000 and SP16. According to the loads assigned from IS 875 1987 (Part I and Part II) the structural members has found safe.

Key Words: Structural member, design, Analysis.

1. INTRODUCTION

Nowadays, due to the increase in population leads to the availability of horizontal coordination system (due to large area available per person) has been decreasing so that adoption of vertical co-ordination System (high-rise building due to deficiency of area) is needed.

ETABS can also handle the largest and most complex building models, including a wide range of nonlinear behaviors, making it the tool of choice for structural engineers in the building industry. ETABS can be effectively used in the analysis and design of building structures which might consists of structural members like beams, columns, slabs, shear walls etc. With ETABS you can easily apply various construction materials to your structural members like concrete, structural steel, Reinforced Concrete etc. ETABS automatically generates the self-weight and the resultant gravity and lateral loads.

Codes recommended are IS 456-2000, SP 16, IS 875-1987 (Part I), IS 875-1987 (Part II).

1.2 OBJECTIVES

➢ To provide a stay for students of Jain Institute of Technology and to help new arrivals to
become acclimatised and adjusted to the new environment.

➢ To promote availability of safe and convenient location for students with care facility.
➢ To offer the right atmosphere for study and interchange of thoughts and ideas.
➢ Reduce the current accommodation crisis at the college.

2. METHODOLOGY

Accordingly a new hostel building is needed that can accommodate number of staying rooms, dining hall, kitchen, study hall/library, sports room(indoor games, aerobic room), electric room, visitors room, office room, dispensary, laundry and general store rooms.

**Geometry of the Hostel building**

The plan of the Hostel building is irregular. It has a story height of \( H = 3.2 \text{m} \) where all stories are of the same height. The hostel building consist of three stories, it is four stories including ground floor. The Hostel building length is 66.23m and width is 50.23m so the area is 3326.73m\(^2\).The building consist of square columns with cross section (0.3 x 0.45)m, rectangular beams with cross- section (0.23 x 0.3)m and slab thickness of 150mm. The size of column is constant for all stories. In each storey, the size of the beam is constant.

**Structural Design**

**Plan Details**

Dimensions are in m and an 11 story building is modelled by ETAB Software and plan by AUTO CADD. The height of each story is kept as 3.2m in the structure with the total height of the structure as 11.1m and Hostel building length is 66.23m and width is 50.23m so the area is 3326.73m\(^2\). Analysis and design of the structure is done by the software. Plan detail are shown in Table No.1

![Fig. no.1: Plan of Ground Floor](image1)

![Fig.no.2: First, second and third floor plan](image2)
### Table no 1: Building details

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>ROOMS</th>
<th>SIZES(M)</th>
<th>Area (M²)</th>
<th>No's</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stairs</td>
<td>13X3</td>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Electrical Room</td>
<td>5X4.5</td>
<td>22.5</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Office Room</td>
<td>5X4.5</td>
<td>22.5</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Store Room</td>
<td>5X4.5</td>
<td>22.5</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Library And Reading Hall</td>
<td>(15X4.5)+ (10X4.5)</td>
<td>112.5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Indoor Games Room</td>
<td>(15X4.5)+ (10X4.5)</td>
<td>112.5</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Warden Room</td>
<td>5X4.5</td>
<td>22.5</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Kitchen And Dining Hall</td>
<td>(15X4.5)+ (10X4.5)</td>
<td>112.5</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Wash Room</td>
<td>5X12</td>
<td>60</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>Room Type A (First Floor)</td>
<td>5X4.5</td>
<td>22.5</td>
<td>20</td>
</tr>
<tr>
<td>11</td>
<td>Room Type B (First Floor)</td>
<td>5X9</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Room Type A (Second Floor)</td>
<td>5X4.5</td>
<td>22.5</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>Room Type B (Second Floor)</td>
<td>5X9</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>Entertainment Hall</td>
<td>5X9</td>
<td>45</td>
<td>1</td>
</tr>
</tbody>
</table>

### DESIGN DETAILS

#### Design of Isolated Footing

Given

- Size of the column
  - Longer side= 450 mm
  - Shorter side= 300 mm
  - Load by Column= 658.05 KN

- Characteristic strength of concrete= 25 N/mm²
- Characteristic strength of Steel= 500 N/mm²

Safe bearing capacity of soil= 140 KN/m

Factored safe bearing capacity of soil= 210

Stress Fck= 25 N/mm²

Fy= 500 N/mm²

Size of footing

- Load of column= 658.05 KN
- Self weight of footing(10%)= 65.81 KN
- Total load=Wu= 723.86 KN

Footing Area= 3.45 mm²

\( a = b \)

\( a \times b \times x \)

- Area= 0.51 mm

Short side of Footing= 1.52 m

Long side of footing= 2.27 m

Adopt rectangular footing= 2X3

Factored soil pressure at base is \( P_u \)= 109.68 KN/m

By \( P_u < 1.5 \) SBC, Safe

Factored Bending moment

- Cantilever Projection(Short side)= 1.28 mm
- Cantilever Projection(long side)= 0.85 mm
- Bending moment(Short)= 89.15 KN-m
side)=  
Bending moment(long side)= 39.62 KN-m  

Design of columns

Design of column (C1)

Size of the column= 300X45

Depth of footing
From moment consideration
Mu=0.138fckbd2
d= 160.75 mm
D= 210.75 mm

From Shear consideration
VuL=250(1250-d)N
Assuming tc=0.36N/mm2,Pt=0.25
d= 512.30 mm
D= 562.30 mm
Depth of footing= 512.30 mm

Reinforcement in footing
Area of steel for Longer direction=
7909.7 mm²
406.9 mm²
406.9 mm²

16mm dia provided at
Spacing provided= 300 mm
1536.9 mm
300.0 mm

Area of steel for Shorter direction=
7423.9 mm²
179.9 mm²
179.9 mm²

12 mm dia provided
atSpacing provided= 450 mm
2561.5 mm
450 mm

Ratio of long to short side=β= 1.5

Reinforcement in the central band width of 2m
Provide no
5.966
6.000

Minimum Reinforcement = 0.12% of gross area
1349.5 mm²
1349.5 mm²

Check for shear Stress
Vu= 56.19 KN
100Ast/bd= 0.08
ζc from code book = 0.29

ζv= 0.11 KN
ζv<ζc Safe

Ac= 1 mm²
Puz= 1765.68 KN
Design of Slabs

All four side continuous

<table>
<thead>
<tr>
<th>type side continuous</th>
<th>simply</th>
</tr>
</thead>
</table>

**Effective span** 3625 mm

**Loads**
- live load 4 KN/mm²
- Floor Finish 0.6 KN/mm²
- self weight 3.75 KN/mm²
- total load 8.35 KN/mm²
- Design ultimated load 12.525 KN/mm²

**Ultimate design moments and shear force**

Refer table 26 of IS:456 Code

<table>
<thead>
<tr>
<th>Ly/Lx</th>
<th>1.29</th>
</tr>
</thead>
<tbody>
<tr>
<td>αx</td>
<td>0.077</td>
</tr>
<tr>
<td>αy</td>
<td>0.056</td>
</tr>
<tr>
<td>Muy=αy<em>Wu</em>Lx*Lx</td>
<td>12.67 KN-m</td>
</tr>
</tbody>
</table>

**Checking for one way or 2 way slab**

<table>
<thead>
<tr>
<th>Ly/Lx</th>
<th>1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two way slab</td>
<td></td>
</tr>
</tbody>
</table>

| Thickness of slab | 100 Mm |
| Simple | 28 |
| Continuous | 32 |
| Depth(d) =(Span /28 or 32) | 125 Mm |
| Over all depth (D) | 150 Mm |

| Effective span clear span+Effective depth | 3625 Mm |
| Centre to centre of support | 3730 mm |

**Check for depth** .138*fck*b*d*d

| Depth= | 67.76 mm |
| Hence the depth taken is safe |

Reinforcement (Short and Long span )

| For Short span | 5728.82 mm² |
| Vux=0.5*Wu*Lx | 22.70 KN |
| Muy=αy*Wu*Lx*Lx | 9.22 KN-m |
| Mu max= | 12.67 KN-m |

Spacing of 10mm dia bars 300 mm

effective span 5000.0 mm
Materials
grade of cement Fck25 N/mm²
Steel grade Fe500 N/mm²

For long span

effective depth 115 mm

Stress
Fck= 25.0 N/mm²
Fy= 500.0 N/mm²
Es= 200000

Ast 5310.50 mm²
231.67 mm²

diameter of bar of distribution and main(mm)= 8.0 12
Cross sectional dimension

-solving Ast= 231.67 mm²
-spacing of bars mimnmum
450 mm
575 mm

Effective Depth
span(m) L/d ratio
<4000 20
>5000 10

L/d Ratio 10.0
Clear cover 50.0 mm
over all depth 270.0 mm
Effective span 240.0 mm

Ultimate moments and Shear Force
Mu=.125*Wu*L*L 62.7 KN-m
Vu=.5*Wu*L 86.0 KN

Check for Shear Stress
Considering the short span and unit width of slab

Vu/bd 0.18 N/mm²

Tension Reinforcement
Fe415 .138*fck*b*d*d
Fe500 .134*fck*b*d*d

100Ast/bd

0.24

Fc= .134*fck*b*d*d

0.87*Fy 435.0

Fsc<0.87Fy= 418.2

Hence the Shear stress is safe

Mu>Mu,lim

Doubly reinforced section

Check for deflection
(L/D)basic= 32

From IS 456-2000 pg no 70

(L/D)actual= 29

Xu, max/ d

Hence deflection is safe

0.5

Xu, max

124.2

Fsc= 418.2

0.87*Fy 435.0

Xu, max/d

50.0 0.46

500.0 0.48

70

0.53

415.0

Design of Beam

Beam 1

depth 270.0 mm

Xu, max/d

Fsc= 418.2

0.87*Fy 435.0

Fsc<0.87Fy= 418.2

Asc= 71.0

Areas of the bar= 50.3

Breadth of beam 230.0 mm

Width of support 230.0 mm

No of bars provide= 1.4
Approximately 2.0

Provide 2.0 r
Area of steel provide= 100.6 mm²

Ast2= AscFsc/0.87Fy 68.2 mm²
0.36FckbXu,lim/0.8

Ast1= 7Fy 591.0 mm²

Total tension reinforcement=Ast= t2 659.3

No of bars= 5.8
Approximately 6.0

Shear reinforcement

ζv= Vu/bd 1.4 KN/m
Pt= 100Ast/bd 1.1

Refer Table no 19 of IS 45-2000

ζc= 0.7 KN/m

If ζv≥ζc, shear force is required or not required Vus=

Spacing should be given= 45.6 KN/m
0.87AsvFyd/Vus 213.8 mm or maximum 300 mm

maximum spacing= 0.75d 202.5 mm
202.5 mm

Spacing should be given= 20.8 safe

4. RESULTS AND DISCUSSIONS

From the ETABS the result of axial force, moment at X-X and moment at Y-Y has been taken. These results have grouped into 6 units naming with C on the basis of Axial load with ranging between 250KN difference.

And taking maximum axial load within the range, for the corresponding maximum axial load, the moment at X-X and moment at Y-Y has been taken.

Column Results From ETABS

<table>
<thead>
<tr>
<th>Axial Load Ranges (kN)</th>
<th>Column</th>
<th>No. of Column</th>
<th>Maximum M (kNm)</th>
<th>y M (kN-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-750(C1)</td>
<td>G14</td>
<td>8</td>
<td>658.05</td>
<td>13.92</td>
</tr>
<tr>
<td>750-1000(C2)</td>
<td>C6</td>
<td>28</td>
<td>951.91</td>
<td>43.93</td>
</tr>
<tr>
<td>1000-1250(C3)</td>
<td>H3</td>
<td>28</td>
<td>124.89</td>
<td>35.31</td>
</tr>
<tr>
<td>1250-1500(C4)</td>
<td>F8</td>
<td>20</td>
<td>148.612</td>
<td>36.16</td>
</tr>
<tr>
<td>1500-1750(C5)</td>
<td>D8</td>
<td>20</td>
<td>169.047</td>
<td>36.90</td>
</tr>
<tr>
<td>1750-2000(C6)</td>
<td>F9</td>
<td>8</td>
<td>185.023</td>
<td>2.43</td>
</tr>
</tbody>
</table>

➢ From the ETABS software we know the value of Minimum tension reinforcement (Pt) of the column in our model is i.e. 0.8% which is in the recommended range between 0.8 to 4%.
For slab minimum tension reinforcement (P_s) is 0.09% which is less than 0.12% by recommended value.

For beam minimum tension reinforcement (P_b) we got 0.27% which is in range between 0.17 to 4%.

3. CONCLUSIONS

- In this present work ETABS is used to analyze the R.C moment resting frame structure of G+3 considering the gravity loads. The following conclusion is drawn from present work.
- G+3 Hostel building plan has been drawn in Auto CAD software and designed for Beams, Columns, Footings, stairs and slabs. The dead load, live load are referred using IS 875-1987
- Part I and Part II. And designed according to the IS 456-2000 and SP16 by considering concrete grade of M25 and steel of HYSD bars Fe500 are used.
- By proposing our project on girls hostel building which meets the requirements of our JIT girls.
- The results obtained are safe from manual calculation i.e., in MS Excel as well as in software results.
- Manual design has been done for one of the different dimensions of the beam, column, stairs, footing and slab of the Hostel building as per the IS 456-2000 and SP 16.

REFERENCES


BIOGRAPHIES

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