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"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 = 3.2m 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

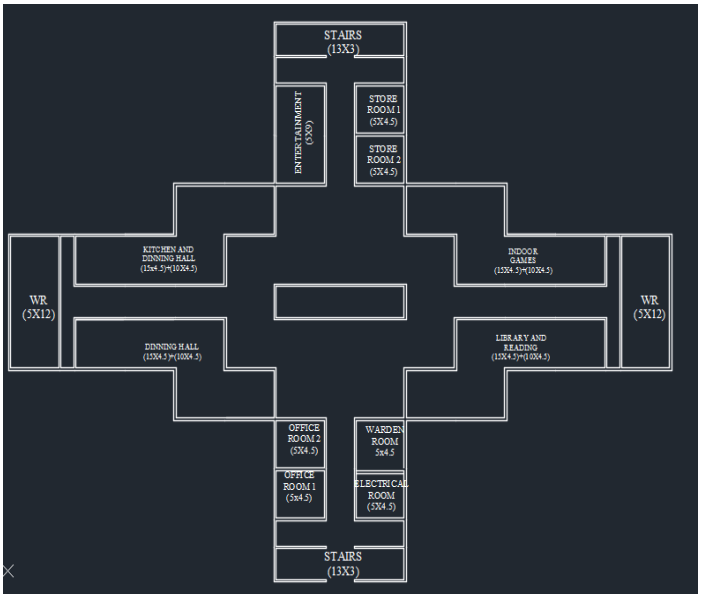

Fig. no.1: Plan of Ground Floor

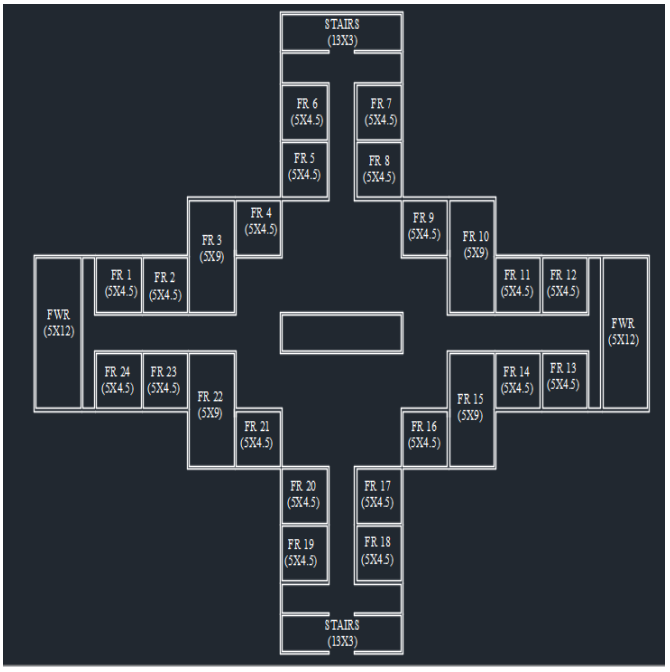

Fig.no.2: First, second and third floor plan

Table no 1:Building details

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

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
Characterstic strenght of concrete=	25	N/mm^2
Characterstic strenght of Steel=	500	N/mm^2
Safe bearing capacity of soil=	140	KN/m
Factored safe bearing capacity of soil=	210	
Stress Fck=	25	N/mm^2
Fy=	500	N/mm^2
Size of footing		
Load of column=	658.05	KN
Self wieght of footing(10%)=	65.81	KN
Total load=Wu=	723.86	KN
Footing Area=	3.45	mm^2
a=b		
axXbx=	Area	
x=	0.51	mm
Short side of Footing=	1.52	2
Long side of foooting=	2.27	3
Adopt rectangular footing=	2X3	
Factored soil pressure at base is Pu=	109.68	KN/m
By Pu<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
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 τc=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	mm^2
	406.9	mm^2
	406.9	mm^2
16mm dia provided at		
Spacing provided=	300	mm
	1536.9	mm
	300.0	mm
Area of steel for Shorter direction=	7423.9	mm^2
	179.9	mm^2
	179.9	mm^2
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		
(2/(β+1)Ast	143.92	
Minimum Reinforcement =	0.12% of gross area	
	1349.5	mm^2
	1349.5	mm^2
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	

Design of columns

Design of column (C_1)

Sizeof the column=	300X450	mm
breadth=	300	mm
depth=	450	mm
Effective length of the column=Lex=	3200	mm
Effective length of the column=Ley=	3200	mm
Factored Load(Pu)=	1850.23	KN
Factored Moment(Mux)=	2.435	KN-m
(Muy)=	25.47	KN-m
Grade of concrete(Fck)=	25	N/mm^2
Grade of steel(Fy)=	500	N/mm^2
Fck=	25	N/mm^2
Fy=	500	N/mm^2
d'=	40	mm
Uniaxial MU=	29.424	KN-m
Pu/Fckbd=	0.548	
MU/Fck bd2=	0.019	
d'/D=	0.089	
From Sp 16 Chart no 48	0.020	
P/Fck=	0.020	
P=	0.500	
Asc=	675	mm^2
Provide no	5.966	
	6.000	
Actual area	678.857	mm^2
Actual p	0.503	
P/Fck	0.020	
From chart 48	0.060	
Mux1/Fxkbd2=	91.125	
Muy1/Fckbd2=	91.125	
Ac=	134321.1	mm^2
Puz=	1765.68	KN

PU/Puz=	1.048
αn=	2.413
(Mux/Mux1)αn=	0.000
(Muy+Muy1)αn=	0.046
(Mux/Mu1)αn+(Muy+Mu1)αn=	0.046
Hence safe	

Design of Slabs

All four side continuous

type support	simply	
size of slab		
Length of short side of slab(Lx)	3500	Mm
Length of long side of slab(Ly)	4500	Mm
Wall thickness	230	Mm
Charcterstic strenght of Steel(Fy) and concrete(Fck)	415	20
Live Load	4	KN/mm^2
Floor finish	0.6	KN/mm^2
Checking for one way or 2 way slab		
Ly/Lx	1.3	
Two way slab		
Thickness of slab	100	Mm
Simply	28	
Continous	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
Effective span	3625	mm
Loads		
live load	4	KN/mm^2
Floor Finish	0.6	KN/mm^2
self wight	3.75	KN/mm^2
total load	8.35	KN/mm^2
Design ultimated load	12.525	KN/mm^2
Ultimate design moments and shear force		
Refer table 26 of IS:456 Code		
Ly/Lx	1.29	
From the Table		
αx=	0.077	
αy=	0.056	
Mux=αx*Wu*Lx*Lx	12.67	KN-m
Muy=αy*Wu*Lx*Lx	9.22	KN-m
Mu max=	12.67	KN-m
Vux=0.5*Wu*Lx	22.70	KN
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	mm^2
	295.28	mm^2
Solving Ast=	295.28	mm^2
spacing of bars minimum	300	mm
3d	375	mm

Spacing of 10mm dia bars	300	mm
For long span		
effective depth	115	mm
Ast	5310.50	mm^2
	231.67	mm^2
solving Ast=	231.67	mm^2
spacing of bars mimnmum	450	mm
	575	mm
Spacing of 10mm dia bars	450	mm
Check for Shear Stress Considering the short span and unit width of slab		
ζv=	Vu/bd	
	0.18	N/mm^2
Pt=	100Ast/bd	
	0.24	
ζc=	0.35	N/mm^2
Hence the Shear stress is	safe	
Check for deflection		
(L/D)basic=	32	
(L/D)actual=	29	
Hence deflection is	safe	

Design of Beam

Beam 1

depth	270.0	mm
Breadth of beam	230.0	mm
Width of support	230.0	mm
effective span	5000.0	mm
Materials		
grade of cement	Fck25	N/mm^2
Steel grade	Fe500	N/mm^2
Stress		
Fck=	25.0	N/mm^2
Fy=	500.0	N/mm^2
Es=	200000	
Diameter of bar of distribution and main(mm)=	8.0	12
Cross sectional dimention		
	span(mm)	L/d ratio
Effective Depth	<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
Tension Reinforcement		
Fe415	.138*fck*b*d*d	
Fe500	.134*fck*b*d*d	
	.134*fck*b*d*d	
Mu.lim	56.2	
Mu>Mu,lim	Doubly reinforced section	
From IS 456-2000 pg no 70	Fy	Xu,max/d
	250.0	0.53
	415.0	0.48
	500.0	0.46
Xu,max/d	0.5	
Xu,max	124.2	
Fsc=	418.2	
0.87*Fy	435.0	
Fsc<0.87Fy=	418.2	
Asc=	((Mu-Mu,lim)/Fsc(d-d'))	
	71.0	
Areas of the bar=	50.3	

No of bars provide=	1.4	
Approximately	2.0	
		no. of bars of 16mm diameter
Provide	2.0	
Area of steel provide=	100.6	mm^2
Ast2=	AscFsc/0.87Fy	
	68.2	mm^2
Ast1=	0.36FckbXu,lim/0.87Fy	
	591.0	mm^2
Total tension reinforcement=Ast=	Ast1+Ast2	
	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	provide	
Vus=	[Vu-(ζcbd)]	
	45.6	KN/m
Spacing should be given=	0.87AsvFyd/Vus	
	213.8	mm or maximum 300
maximum spacing=	0.75d	mm
	202.5	mm
Spacing should be given=	202.5	mm
Check for Deflection control		
(L/d)max=(L/d)basic*Kt*Kc*Kf	20*0.9*1*1	
	21.0	
(L/d)actual=	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

Axial Load Ranges (kN)	Column	No.of Column	Maximum	M_x (kN-m)	M_y (kN-m)
500-750(C_1)	G14	8	658.05	13.92	44.40
750-1000 (C_2)	C6	28	951.91	43.93	40.48
1000-1250(C_3)	H3	28	1248.89	35.31	49.82
1250-1500(C_4)	F8	20	1486.12	36.16	21.17
1500-1750(C_5)	D8	20	1690.47	36.90	0.81
1750-2000(C_6)	F9	8	1850.23	2.43	25.47

- From the ETABS software we know the value of Minimum tension reinforcement (P_t) 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_t) is 0.09% which is less than 0.12% by recommended value.
- For beam minimum tension reinforcement (P_t) 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.

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