'Planning Designing & Estimating of Residential Building'

Mr. Suyog R Jadhav[1], Ms. Sejal S Bhogan[2], Ms. Renuka V Bhogan[3], Mr. Sahil D Sawant[4], Mr. Mukul M Chodankar[5], Prof. Keshav Ramdas Manerikar[6]

[1-6]Department of Civil Engineering, Yashwantrao Bhonsale Polytechnic, Sawantwadi, Sindhudurg, Maharashtra

---***---

Abstract - *The principal objective of this project is to planning designing and estimation of Residential Building. the first objective of this project is to realize sufficient knowledge in planning, designing and estimating. Our project deals with the plan and style of Residential Building. Designing involves identifying the hundreds which influence a structure and therefore the forces and stresses which arise within that structure thanks to those loads, perform analysis to urge moments and shear forces on different elements of the structure then design the structure for ultimate loads and moments. The hundreds are often self-weight of the structures, other dead loads, live loads, moving (wheel) loads, wind load, earthquake load, load from natural process etc. Auto CAD may be a software tool to style functional design of plan. Estimation includes finding the quantities of materials required for the development of the structure and requirements of labour etc., finally determining the general cost of the structure before execution of labour. During this project work, an effort is formed consistent with Building by laws and style of residential building as per is: 456-2000, IS-1200 and SSR. The layout planning may be a part of urban development it includes planning of residential houses, commercial complexes, service roads, primary health centers, school...& other amenities sewerage system for whole layout (includes treatment, sewer main , storm water drains), water distribution system. This article includes design& estimation of residential building in plot of layout planned.*

Key Words: Planning, Designing, Estimating, Building

1. INTRODUCTION

Shelter is the one of the basic needs of the habitation. In this project we have complete the planning designing and estimating of the residential building. The project is completed with the references to the Indian standard codes. In our project we are introducing our topic "Planning, Designing and Estimating of Residential Building". Structural design is an art and art and science of designing with economy and elegance, a safe, serviceable and a durable structure. The entire process of structural planning and style requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and bye-laws, backed by sample experience, institution and judgment. In this project, an attempt is made on planning, design and estimation of residential building. The main object of our project is to know the various aspect of building like planning, designing and estimation. Before construction of any residential building, we required making plan on AutoCAD, normally AutoCAD software is used for planning of residential building in 2D drawings form that we can draw elevation and sections of buildings and Revit is used to draw 3D drawing. The design of residential building is administered as per Limit State analysis. The various IS code are used for design of Residential building. Estimations are completed by using rates from schedule of Rate (2020-21) by Public Work Department.

1.1 Problem Definition:

Planning:

Planning of the residential building is the arrangements of the various components of units of a building in systematic manner so as to forma meaningful and homogeneous structure to meet its functional purpose. Building planning is the graphical representation of a building will be looked like after construction.

Design:

The design is process of section percussion from the analysis results by using suitable analysis method. The aim of design is to achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life

Estimation:

A cost estimate is defined for this report/project as the initial projected building construction cost figure. Cost estimation is the process by which, based on information available at a particular phase of project development, the ultimate cost of a project is estimated. This quantification of cost is the initial figure that allows the project to proceed to the next phases for final design and construction.

Aim of Project:

The aim of the project is to plan, design and estimation of framed structure of a residential building.

2. SCOPE OF PROJECT

This project is about Planning, Designing and Estimating of Residential building. Building planning is the arrangement of various component or unit of a building in systematic manner so as to form a meaning and homogeneous structure to meet its functional purpose. It is by builder and contractor to construct buildings of all kinds. Building planning is also useful when it is essential to estimate how much a project will cost and preparing project budgets building planning is also useful. When approaching the designing of residential building, the thing to consider is occupants, lighting and ventilation. By considering all these factors the scaled plan is designed. This ensures efficient use of floor space without wasting it. If done right, it accounts for all possible use of a given space. An estimate is process by which based on information available at a particular phase of project, the estimate is determining the feasibility and profitability of a potential project. An accurate estimation keeps all parties focused on delivering a project on time and under budget.

Table -1: Details of the Project:

Type of Building	Residential Building
Type of Structure Frame	Frame Structure
Number of Floors	3 (G + 2)
Floor to Floor Height	2.9 m
Height of Plinth	0.6 m.
Plot Area of Building	1548.00 Sq.m.
Plot Detail	Front – Service road followed a green zone from the between Dodamarg and Bhedasi.
Type of Apartment	1BHK

Arrangement of Rooms

Living room – This is the area for general use where family spends much of their time. It is usually near the entrance of the house. During winters, this area receives much of the sunshine and in summer, the sunrays enter from southern part.

Kitchen – this is usually made in the eastern side of the plot for morning sunshine, which refreshes and purifies the air.

Bedroom– this area should provide privacy to the members and should provide provision for table, chairs, and cupboards. Attached toilets may be provided for ease of convenience.

Bath & W.C. – Usually, bath and W.C. are combined in a single room and attached to bedroom for increase of convenience and privacy. The bathroom is usually made white with glazed tiles with complete showers, bathtubs etc.

Verandah – A residential building must be provided with open verandahs at the front and rear side of the home. This verandah provides protection to the home from sunrays, wind and rain. It also provides with a place to sit and enjoy. This area varies between 10%-20% of the total area.

Stair case– The staircase should be placed in the front of the building if it is intended for visitors and should be placed at the back of the home if family members would use it more. Rises & treads should be uniform to smooth movement.

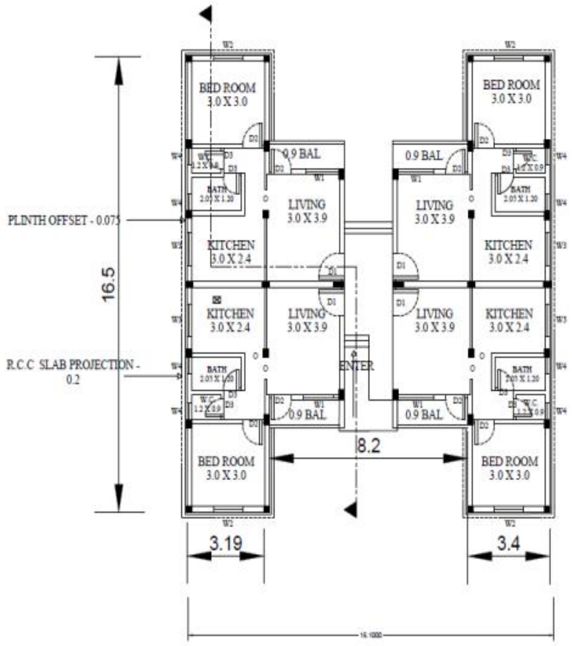

Fig -1: Ground floor plan

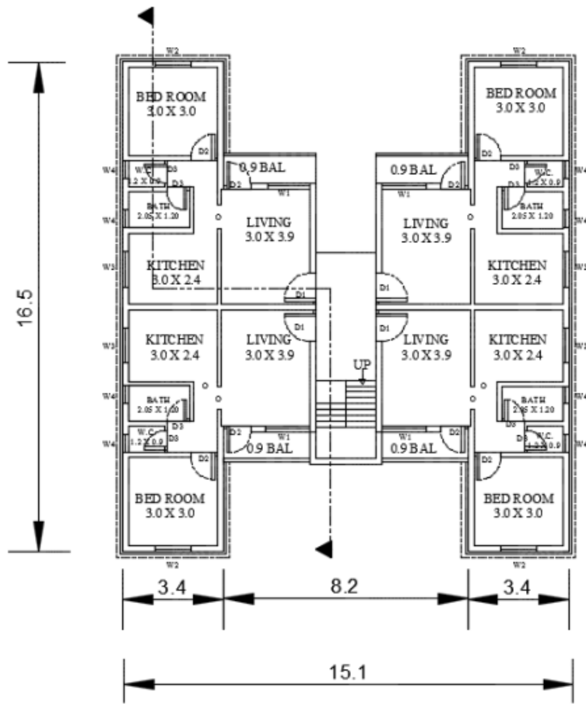

Fig -2: First and second floor

Fig -3: 3D view of Building

3. DETAILS OF DESIGN

Design of Slab is plane structural members whose thickness is small as compared to its length and breadth. Slabs are most frequently used as roof covering and floors in various shapes such as square, rectangular, circular, triangle, etc. in building. Slabs supports mainly transverse loads and transfers them to the supports by bending action in one or more directions. Beams or walls are the common supports for the slabs.

Types of Slabs
One Way Slab
Two Way Slab
Cantilever Slab

3.1 Slab Design of Bed Room Area (S1)

Dimension of Slab (3.2 × 3.2)
M20 grade concrete, Fe 415 HYSD bar
Check for Slab
Span Ration = Ly/Lx = 3200/3200 = 1 < 2
The Slab should be designed as two way slab.
Given:
lx = 3.2 m = 3200 mm.
ly = 3.2 m =3200 mm.
αx = 0.062.
αy = 0.062.
F.F. = 1 KN/m2
L.L = 2.9 KN/m2

Step 1: Estimation of Slab Thickness (davail)
If lx < 3.5 and L.L. < 3 KN/m2.
D = lx /35 ×0.8
= 3200 /35 ×0.8
D = 114.28 mm ≅ 120 mm.
Assume ∅ = 08 mm and dc = 15mm
davail = D - dc - ∅ /2
= 120 - 15 - 8 /2
davail = 101 mm

Step 2: Effective Span (le)
For cantilever slab, effective span (le) is taken as: le x= 3.2 m

Step 3: Determine the Intensity of UDL (w)
Load Calculation
a. Self-weight of Slab = (1 1 D) 25 = (1 1 0.12) 25 = 3 KN/m.
b. Floor Finish = 1 1 F.F. = 1 1 1 = 1 KN/m.
c. Live Load = 1 1 L.L. = 1 1 2.9 = 2.9 KN/m.
Total Load = w = a + b + c = 3 + 1 + 2.9 = 6.9 KN/m.
Design of Udl = wd = w f = 6.9 1.5 = 10.35 KN/m.

Step 4: Calculate Design Moment (Md)
Mxd = x wd l2xe = 0.062 10.35 3.22 = 6.57 KN.m
Myd = y wd l2xe = 0.062 10.35 3.22 = 6.57 KN.m

Step 5: Calculate Required Effective Depth (d reqd) and Overall Thickness (D)
Calculate (dreqd) by equating:
Mulim = Mxd
For M20 and Fe 415
0.138 fck b d2 = 6.57 106
0.138 20 1000 d2reqd = 6.57 106
d reqd = 48.79 mm < davail (101 mm) ……hence Safe.

Step 6: Calculate Area (Astx) and Spacing (Sx) of main steel X - direction.
Area of main steel (Assume suitable diameter of main bar - 8 mm, 10 mm or 12 mm)
Astx = 0.5fck /fy (1- √1- (4.6 Mxd)/ (fck ×b×d^2)) ×b×d
= 0.5 × 20 /415 (1- √1- (4.6 ×6.57×10^6)/ (20 × 1000× 〖101〗 ^2)) ×1000×101
Astx = 187.47 mm2

Spacing of main steel is taken as least of:
Sx = 1000 × A∅ /Astx
= (1000 × π/4×8^2)/187.47
= 268.12 mm.
Sx = 3d
= 3 × 101
= 300 mm
Sx = 300 mm
Provide Sx = Sx = 268.12 mm ≅ 260mm C – C

Step 7: Calculate Area (Asty) and Spacing (Sy) of Main Steel Y - direction.
d' = d - ∅ = 101 - 10 = 91 mm
Asty = 0.5fck/fy (1- √1- (4.6 Myd)/ (fck ×b×d^'2)) ×b×d'
= 0.5 × 20/415(1- √1- (4.6 ×6.57×10^6)/ (20 × 1000× 〖91〗 ^2)) ×1000×91
Asty = 210.13 mm2
Spacing of Main Steel is taken as least of
Sy = 1000 × A∅ /Astd
= (1000 × π/4×8^2)/210.13
= 239.21 mm
Sy = 3 × d' = 3 × 9
= 273 mm.
Sy = 300 mm.
Provide Sy = 239.21 mm ≅ 230 mm

Table: 2 Design of Slab:-

Sr. No.	Type of Slab	Size of Slab (mm)	Main Reinforcement		Distribution Reinforcement		Depth (mm)
			Diameter (mm)	Spacing (mm)	Diameter (mm)	Spacing (mm)	
1	Two Way Slab (S1)	320 x 320	8	260	8	230	200
2	Two Way Slab (S2)	240 x 320	8	210	8	120	
3	Two Way Slab (S3)	260 x320	8	240	8	210	
4	Two Way Slab (S4)	310 x 410	10	300	10	270	
5	Cantilever Slab (S5)	110 x320	10	300	8	290	

3.2 Design of Beam

Concrete is fairly strong in compression but very weak in tension. Hence Plain concrete cannot be used in situation where considerable tensile stresses develop. If flexural member like beams and slabs are made of plain concrete their load carrying capacity is very low due to its low tensile strength. Since Steel is very strong in tension steel bars are provided to resist tensile stress at a place where the maximum tensile stresses are developed. In case of simply supported beam, tensile stresses are induced in bottom layer because of positive bending moment (sagging bending moment) and hence steel bars are provided near the bottom of the beam.

There are three types of reinforced concrete beams:

1) Singly reinforced beams.
2) Doubly reinforced beams and
3) Singly or doubly reinforced flanged beams.

Design of Beam

B1

Beam Size =230 × 230

b = d/2

le =Span = 0.23/2 + 3 + 0.23/2 = 3.23 m

w = 20 KN/m.

Mu = $(wd \times le^2)/8$

= $(20 \times (3.23)^2)/8$

Mu = 26.082 KN.m

Step 1: Calculate design moment

Md = Mu × γf

= 26.082 × 1.5

= 39.123 KN.m

Md = 39.123 × 106 N.mm.

Step 2: Calculate Mulim for balanced section for Fe 250.

Mulim = 0.149 fck bd2

Step 3: Calculate d, by equating

Mulim = Md

0.149 fck bd2 = 39.123 × 106

0.149 × 20 × d/2 × d2 = 39.123 × 106

2.98 × (d^3)/2 = 39.123 × 106

1.49 d^3 = 39.123 × 106

d^3 = 26257046.98

d = 297.223 mm ≅ 300 mm

Step 3: Calculate D and b

Assume effective cover d' = 40 mm

D = d + d'

= 300 + 40

= 340 mm

and

b = d/2

= 300/2

= 150 mm

Step 4: Calculate area of reinforcement Ast

Ast = (Ptlim ×b ×d)/100

= (0.088 fck ×b ×d)/100

(For Fe 250 = Ptlim = 0.088 fck)

= (0.088 ×20 ×150 ×300)/100

Ast = 792 mm^2

Step 5: Calculate no. of bars required

(Assume bar diameter = 8 mm)

No. of bars required = Ast/ (π/ (4) × $Ø^2$)

= 792/ (π/ (4) × 20^2)

= 2.52 ≅ 3 Nos.

Provide 3 bars of 20 mm diameter on tension side.

Table: 3 Design of Beam:-

Sr. No.	Beam No.	Size of Beam (mm)	Span (mm)	Cover (mm)	Diameter	No of Bars	Depth
1	B1	230 × 230	3230	40	20	2	300
2	B2	230 × 230	3230	40	20	3	300
3	B3	230 × 230	2480	40	20	2	250
4	B4	230 × 230	2630	40	20	2	260
5	B5	230 × 230	3375	40	20	2	350
6	B6	230 × 230	4202	40	20	4	360

3.3 Design of Column

A vertical member whose effective length is greater than 3 times its least lateral dimension carrying compressive loads is called as column transfer the loads from the beams of slabs to the footing or foundations. The inclined member carrying compressive loads as in case of frames and trusses is called as struts. Pedestal is a vertical compression member whose effective length is less than 3 times its least lateral dimension. Generally the column may be square, rectangular or circular in shape.

Short Column.

When this ratio of effective length to the least lateral dimensions of this column is less than 12, then it is known a short column

lef / b ≤ 12

lef = effective length

b = least lateral dimension of column

Long Column
A long or slender column is the one whose ratio of effective length to its least lateral dimension is not less than 12. Then it is termed as a long column.

lef / b ≥12

lef = effective length
b = least lateral dimension of column
Design of Column (C1)
Given:
Column Size = 230 × 450
Breadth = b = 230 mm
Depth = d = 450 mm
fck = 20 N/mm2
fy = 415 N/mm2

Step No. 1: Check of Eccentricity.
emin = L/500 + D/800
= 2440/500 + 450/30
= 19.88 mm
emax = 0.05 × D
= 0.05 × 450
= 22.5 mm
emin (19.88 mm) < emax (22.5 mm) , ...hence safe

Step 2: Design Longitudinal Reinforcement.
Asc = 0.01 × Ag
= 0.01 × (b × D)
= 0.01 × (230 × 450)
= 1035 mm2
(Select bar diameter and number of bars having total area approximately equal to Asc)
Provide 8 bars of 12 mm diameter and 2 bars of 25 mm diameter.
Asc. provided = 8 × A20 + 2 × A25
= 8 × π/4 × 122 + 2 × π/4 × 252
= 904.779 + 981.747
= 18886.526 > 1035 mm2....hence safe.
Check for percentage of Steel
Ptprovided = (Asc.provided)/Ag × 100
= 1886.526/((230 ×450)) × 100
Ptprovided = 3.38 %
Ptmin (0.8 %) < Ptprovided (1.82 %) < Ptmax (6 %)
Hence Safe.

Step 3: Design of lateral ties
Diameter of lateral ties is taken greater of :1/4 × diameter of largest bar
= 1/4 × 25
= 6.25 mm
6 mm.
∴ Provide 8 mm diameter lateral ties.
Spacing or pitch of later ties is taken least of:
Least lateral dimension
= 230 mm 16 × Diameter of smallest bar
= 16 × 12 = 192 mm.
300 mm
Provide lateral ties 8 mm Ø @ 192 mm C-C.

Step No. 4: Calculate Ag, Asc and Ac.
Ag = b × D
= 230 × 450
Ag = 103500 mm2
Asc = no. of bars × AØ
= 4 × π/4 × d2
= 8 × π/4 × 122
Asc = 904.79 mm2
Ac = Ag - Asc
= 103500 - 904.79
Ac = 102595.21 mm2

Step No. 5: Calculate Ultimate Load Carrying Capacity of Column Pu.
Pu = (0.4 × fck × Ac) + (0.67 × fy × Asc)
= (0.4 × 20 × 102595.21) + (0.67 × 415 × 904.79)
= 1072338.54 N
Pu = 1072.34 KN

Step No. 6: Calculate Working Load.
Pu = Pu/γf
= 1072.34/1.5
Pu = 714.89 KN.

Table: 4 Design of Column:-

Schedule of column				
Sr. No.	Type	Size in (mm)	Longitudinal Steel	Lateral Tiles
1	C1	230 × 450	12 Ø - 8 No	8 mm Ø @ 192 mm C-C.
2	C2	230 × 375	12 Ø - 6 No	8 mm Ø @ 192 mm C-C.
3	C3	230 × 300	12 Ø - 6 No	8 mm Ø @ 192 mm C-C.
4	C4	230 × 310	12 Ø - 4 No	8 mm Ø @ 192 mm C-C.

3.4 Design of Footing
Foundation is an important part of the structure which transfers the load of the super structure to the foundation soil the foundation distributes the load over a hanger area so that the pressure on the soil does not exceed its allowable bearing capacity and restricts the settlement of the structure with in the permissible limits. Foundation increases the stability of the structure. Foundations may be shallow or deep foundation depending up on the load and type of foundation soil if the load to be supported is very high and soil is of low bearing capacity deep foundation like pile foundation well foundation etc. are provide if the soil with adequate bearing capacity is available at reasonable depth, shallow foundation are provided.
Types of column footing
One Way shear consideration (Wide beam theory)
Two way shear consideration (Punching shear)
Design of Footing (F1)
Given:
Column Size = 230 mm × 450 mm
Footing Size = 2250 mm × 2250 mm
fck = M20:
fy = Fe 415.
Factored Load = 800 KN -on column;
Self-weight = 5%
Ultimate bearing capacity = 300 KPa

Step 1: Calculate Bending Moment
Upward soil pressure (P)
= (Factored load on Column)/ (Size provided)

= (1.5 × 800)/ (2.25 ×2.25)

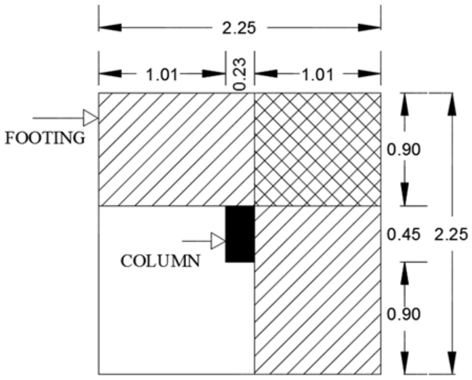

Fig: 4 Footing and Column Plan

P = 237.037 KN/m2
Mx = 1 × 1.01 × 237.037 × 1.01/2
= 120.90 KN.m
My = 1 × 0.9 × 237.037 × 0.9/2
= 95.99 KN.m

Step 2: Calculate dreqd

Mumax = 0.138 fck bd2 ...for Fe 415
Equating Mumax to Mx
0.138 fck bd2 = 120.90 × 106
0.138 × 20 × 230 × d2 = 120.90 × 106
dreqd = 436.409 mm say 440 mm
Assuming cover 70 mm
D = 440 + 50 = 490 mm

Step 3: Calculate Area (Astx) and Spacing (Sx) in X-Direction

Astx = 0.5fck /fy (1- √1- (4.6 Mu)/(fck ×b×d2)) ×b×d
= 0.5× 20/415 (1- √1- (4.6 ×120.90 ×106)/ (20 ×230 × (4402) 230 × 440
= 944.223 mm2
Assuming 16 mm Ø bars
Spacing Sx = 1000 × AØ /Astx
= (1000 × π/4× (16) 2)/944.223
= 212.93 mm say 210 mm

Step 4: Calculate Area (Asty) and Spacing (Sy) in Y-Direction

Asty = 0.5×20 /415 (1- √1- (4.6 ×95.99 ×106)/ (20 ×230 × (424)2) 230 ×424
Here d' = 440 - diameter of bar used
= 440 - 16
= 424 mm
Asty = 745.654 mm2
Spacing of 16 mm Ø bars
Spacing Sy = 1000 × AØ /Astx
= (1000 × π/4× (16)2)/745.654
= 269.64 mm say 260 mm
In X - direction 16 mm Ø @ 210 mm
In Y - direction 16 mm Ø @ 260 mm

Table: 5 Design of Footing:-

Schedule of footing			
Sr. No.	Footing No. Size	In X -Direction	In Y - Direction
1	F1 2250 X 2250	16 mm Ø @ 210 mm	16 mm Ø @ 260 mm
2	F2 2100 X 2100	16 mm Ø @ 210 mm	16 mm Ø @ 250 mm
3	F3 1800 X 1800	16 mm Ø @ 210 mm	16 mm Ø @ 230 mm
4	F4 1350 X 1350	16 mm Ø @ 230 mm	16 mm Ø @ 260 mm

4. CONCLUSIONS

This project includes the planning of Residential Building using AutoCAD, Design using Is Code and concludes with the cost estimate for the entire project. The cost estimate for the project has been calculated using Long Wall Short Wall Method in Microsoft Excel. For the Abstract cost CPWD Schedule of rates has been followed. In this project Planning, Designing, and Estimating of Residential Building. We all the member of our team has learned to plan a building with reference of National Building Cod of India- 2005.

This project includes the layout of G+2 residential building using AutoCAD, and concludes with the cost estimate for the entire project. The layout of the proposed G+2 residential building is based on a plot of area 1548.00 sq.m.

Planning, designing and estimating, these are the tree steps which are very important while constructing any structure. In this project we have detailed discuss about the planning, designing and estimating of the residential building. In future may be there are different methods are adopt to do the planning designing and estimating. For example there are newly software are comes in future to create plan. New software and advance option are generated to do these processes easily as we think that in future there are new software's, methods and advance option are developed. Especially for students to do their work easily.

REFERENCES

[1] IS 875 (Part 1), Part 1: Dead Loads--Unit Weights of Building Materials (Second revision), Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures, Bureau of Indian Standards, New Delhi, 2000.
[2] IS: 875 (Part 2), Part 2: imposed loads (Second revision), Code of Practice for Design Loads (Other Than Earthquake) For Buildings and Structures, Bureau of Indian Standards, New Delhi, 1987.
[3] Estimating and Costing by B. N. Dutta. (Book).
[4] Estimating, Costing, Specifications & Valuations in Civil Engineering By Monojit Chakraborti (Book).
[5] Is 456: 2000 'Plain and Reinforced concrete – code of practice (Fifth revision).
[6] Design of R.C.C structure by Nilam Sharma

[7] Journal of Advanced Engineering Technology E-ISSN 0976-3945IJAET/Vol.III/ Issue IV/Oct.-Dec., 2012/104-106Research Paper "Earthquake analysis and design vs non earthquake analysis and design using STAAD Pro" ByB. Suresh, P.M.B Raj kiran Nanduri http://dx.doi.org/10.3991/ijet.v7i2.1906
[8] Dr. S.R. Karve & Dr. V.L. Shah - "Illustrated design of Reinforced concrete Buildings"
[9] Reinforced concrete Structures by A.K. Jain and B.C. Punmia for design of beams, columns and Slab.
[10] Fundamentals of Reinforced concrete structure by N. C. Sinha
[11] Reinforced Concrete Vol 1 DR.H.J.SHAH Code Books 1. IS 456-2000 code book for design of beams, columns and slabs 2. SP-16 for design of columns.
[12] Planning, Analysis and Design of Residential Building(G+5) By using STAAD Pro. Dunnala Lakshmi Anuja, V.S.Nagasai PG Scholar, Assistant Professor Srinivasa Institute of Engineering And Technology, Cheyyereu, Amalapuram, A.P, India, Srinivasa Institute of Engineering And Technology, Cheyyereu, Amalapuram, A.P, India. IJEDR 2019 | Volume 7, Issue 3 | ISSN: 2321-9939
[13] Planning Analysis and Design of Residential Building, Quantity Survey B.Pradeep Kumar Sk.Yusuf Basha ISSNNO:2348:4845
[14] D.Ramya, A.V.S.Sai Kumar "Comparative Study on Design and Analysis of Multistoreyed" 4(10), 125– 130, IJESRT, Oct 2015.