

## Design & Analysis of Multistoried Residential Building (G+5) using ETABS software

<sup>1</sup>Dwadasi Venkata Siddharth Rao, <sup>2</sup>Dr. Honey Gaur

Department of Civil Engineering, Kalinga University, Raipur, Chhattisgarh

*sid.rao4646@gmail.com*

Assistant Professor, Department of Civil Engineering, Kalinga University Raipur, Chhattisgarh

*honey.gaur@kalingauniversity.ac.in*

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**Abstract:** ETABS is software which stands for “Extended Three Dimensional Analysis of Building Systems”. This software is useful in the design of high rise multi-floored building in a systematic manner. With the requirement of making the construction work effective and less time consuming in design, this software is made into use. This help us in the design of multi-storied building, here we have used for design of a residential building (G+5).The plan of building has been drafted using AutoCAD software using standard conditions and available built-up area and placing of beam and column as well as the room dimensions are taken care of before construction and according to the dimensions the plans are made. The placement of beam and column also play a major role in the design aspect .The designed and analyses of building frame has been performed using ETABS software. In our project which is “(G+5) Residential building”, we are considering the design as well as analysis for both gravity and lateral loads as stated by Indian Standards. With the help of this software building can be analyzed before the construction, and we can check the failure in the analysis and redesign them, so that failure can be prevented. Once we get the results construction can be done according to design. This project is designed as per INDIAN CODES – IS 1893 part II: 2002, IS 456:2000.

**Keywords:** AutoCAD, ETABS, Design Software, multistory residential building component.

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### I.INTRODUCTION

Whenever we think of Design and Analysis of residential building in 21st century one thing that comes in our mind is that construction of high rise building has been involved. In Ancient times human lived life as Nomads and accommodated themselves either under trees or in the caves to protect themselves from wild animals, and natural sources like sun rain etc. as the time moved on the people started living either in huts made of timber or mud. Now those houses have been made into beautiful and high floored houses which completely changed the lifestyle of the people.

Single storied building generally consists of ground storey only. While multi storied building consist of multiple storeys, typically containing vertical structure in form of ramp, stairs, lift etc. With the need of multi storied building requirement all over the world and the buildings touching the sky, there is a need of safety over the building so that it can sustain the people living there in. Since the bearing capacity of soil is degrading day by day there is a vital need for the checking of its holding capacity.

With new software coming day by day, we can redesign the structure as needed for sustaining the humans. With it, we can make designer apartment, make check for the loading capacity of structure, check for safety of buildings, and predetermine the failure beforehand of the construction .By this advantage, we can predict beforehand life of the building and check for any damages which can be caused during its usage. Structural damages can be reduced and we can take Factor of Safety beforehand for various calamities like earthquake, tsunami so that building suffers less damage after it. Various loading can be imposed over the design module so as to check the validity and suitability. Loading can be of various types such as Live load, Dead Load, Wind load, Earthquake load etc.

This software also help us in the development of 3D view of structure along with the view of top elevation or side or front elevation. Thus with the help of this we can make out how will the structure look when it will get constructed, and gives us idea of the amount of material which will be needed for overall construction. Placing of beams and columns are also suggested by the software so as to reduce the failure or collapse of building.

### **1.1 High Rise Buildings**

Currently High rise buildings or sky scrapers are indicator of progress of both social and economical development of any country. Every one requires their dream house to be in a well designed manner and should be according to their requirement of the people. Due to concentrated and high rise in the population in urban cities taking place, there is a need to accommodate large people with proper planning of their houses. However due to less amount of availability of land and high rise in the cost of land in the cities, construction of high rise buildings are taking place. Since this allow people to purchase house in required area and this also result in beautifying the cities as sky scrapers.

The design and construction of high rise buildings involve safe and habitable space for the people living there, since safety of people is most important in the buildings. The building must support the weight of various elements taken into consideration like steel, concrete, brick etc and easily resist various forces like wind and earthquake, and protect occupants form fire. They should be easy to use and accessible, for the residents of upper floor and should have comfortable climate for the occupants. In civil engineering while construction of a building we take into consideration various components like foundation, plinth, beam, column, placing of the components etc. Structure analysis and design are performed so as to identify that the structure is capable of resisting the applied load and will not fail throughout its life. Prior to design and analysis of the project soil testing is also been performed so as to identify that soil can bear or not the structural load. Since the super-structure is resting on the foundation and the load is transferred to soil or strata using this foundation. With the continuous increase in the high rise building as well as low bearing capacity of soil results in the need for predetermination of the building load and test its standing capability for the future

### **1.2 Significance of Study**

Since construction activities are increasing day by day and people are moving towards apartment culture and that to towards sky scrapers, thus the need of their safety is a major concern. So for their safety and sustainability of building for long term, Engineers and Analysts have tried to develop various software, so that the structure remains safe and it can be designed according to the required purpose of construction.

Now as we can see that every element of construction i.e. foundation, beam, slab, column etc should be analyzed properly and accordingly approval should be given. Since this are the key elements on which total dependency of structure may be seen and if they fail, whole structure may collapse and may lead to huge accident. Thus to avoid this kind of problem and to maintain the structure proper design and its analysis should be done before hand of its approval for the site construction. With this study we can design the buildings according to either earthquake or tsunami prone areas also and it will also provide for the addition of specific materials so that structure is retained.

By this we can prevent the loss of human kind by designing and indulging the specific kind of materials so that they sustain the shocks and loads and do not collapse immediately

### **1.3 Problem Identification**

Since with the increase in the population and more number of people moving towards cities there is a need for the construction of multi storied buildings due to shortage of land available. Thus while construction of these buildings one of the major problem which is generally incurred is the bearing capacity of the structure, and the life span of it. Along with this there has been a gradual rise in the natural calamities like earthquake, tsunami etc. Thus the structure needs to be pre designed according to the natural demand and such that it can sustain the effect of the forces. If this situations are not taken care of, buildings might get damaged and chances may be there that it might collapse, which will result in huge loss of human life, making it unsafe for them to use high rise buildings.

### **1.4 Objectives Of Study**

Following are the objectives of the project-

1. The main objective of the study is to analyze and design G+5 residential building using ETABS.
2. Designing of structural components such as footing, foundation, column, slab, beam by manual method.
3. To design and give reinforcement bar details of the component of structure by using AutoCAD.
4. Plan was developed using AutoCAD software, which was used in the ETABS for analysis.

### **1.5 Assumptions**

1. We assume that slab is continuous over interior supports, and partially fixed over the edges, due to construction in form of monolithic and construction of wall over it.

2. Beams are also assumed to be continuous over the interior support and framing takes place into the ends of columns.

3. M20 grade shall be used for designing, unless specified.

4. For Main reinforcement, Tor steel Fe 415 is used

5. For Distribution reinforcement, Tor steel Fe 415 is used

6. For Shear reinforcement, Mild steel Fe 230 is used

## II. LITERATURE REVIEW

**Sayed A. Ahad<sup>1</sup>, Hashmi S Afzal<sup>2</sup>, Pathan Tabrej<sup>3</sup>, Shaikh Ammar<sup>4</sup>, Shaikh Vikhar<sup>5</sup>, Shivaji Bidve<sup>6</sup>:** Design and Analysis of the residential building which has (G+10) stories has been done. Analysis was done using ETABS software Version 15.2 which proved to be good enough in the design for construction and the structural analysis of all the sections. All the elements of structure like concrete wall, which retains weight of soil are provided. As per soil investigation reports they provided isolated footing. The designing and analysis of RCC frame members such as Beams and Columns were done using ETABS software. The analysis and design were done using standard specifications to the possible extent. The sectional and design analysis were done using STAAD-PRO and result can be compared. The design of a structure must satisfy three basic requirements: Stability - To prevent the overturning due to loads, sliding or buckling in the structure, by the action of loads. Strength - To resist safety due to stresses induced due to loads by various structural elements. Serviceability – so as to get desired performance for service load conditions which implies providing desired stiffness and reinforcement for resisting the deflections crack in structure and resisting vibrations within acceptable limits, and also providing stability and life to structure .

**K. Kiran Mai<sup>1</sup>, Mohd Amer<sup>2</sup>, Md. Shaibaz Ali<sup>3</sup>, Mohammed Fazal Ahmed<sup>4</sup>, Mohammed Omair<sup>5</sup>, Aftab Tanveer<sup>6</sup> :**This paper mainly deals with the analysis done by comparing the results which we have obtained from the analysis of a multi storied building structure through manual method as well as by using ETABS software. Structural analysis implies designing of the structural shape and all the standard dimensions of a particular structure so that it will perform the necessary function for which it was created and will safely withstand the natural and artificial influences which will be acting on it throughout its useful life. In their analysis, they carried out by considering all the necessary seismic zones data and their behavior is assessed by considering type-II Soil condition. In their construction site they considered a plan under zone –IV. Seismic Intensity came out to be Severe and Zone Factor is 0.24

**C.V.S. Lavanya, Emily.P.Pailey, Md. Mansha Sabreen:**

Their project deals with the economical designing method of column so they design the structure in economical way by reducing the section size. Since load is more at bottom in comparison to top floors, less chances occurs of providing large size in top. Column arrangement needs to be economized by arranging its orientation such that span in the longer direction will result in reduction in the amount of bending and as a result the requirement of steel is reduced.. In the building frame, from plinth to terrace the column size may differ i.e. it would be more in upper column so as to reduce the failure in the structure

**S Abhishek<sup>1</sup>, Manoj S K<sup>2</sup>, Roopa B D<sup>3</sup>, Bhagyashree M S<sup>4</sup>, Guruprasad C H M<sup>5</sup>:** They took into consideration residential buildings (G+1) design and analysis using ETABS, wherein they got very productive results through which they got a great industrial exposure and saved their designing time as well as analysis. They took load consideration for the worst cases for the loading in structures. They designed structural components manually as well as on the software and further compared.

**Ragy Jose<sup>1</sup>, Restina Mathew<sup>2</sup>, Sandra Devan<sup>3</sup>, Sankeerthana Venu<sup>4</sup>, Mohith Y:** In their project they analysis the commercial building using ETABS. Their structure which was to be constructed was (G+3) commercial building with floor area of 3441.87 sqft. They analysed the building plan with ETABS software as well as manually and as a result they found out that the results were almost same and the structure responded good for all the floors and stayed safe for the life of structure. During their coarse of work they surveyed the site, soil investigation was done, structural planning was done with AutoCAD. Water content, soil density etc all the laboratory procedures were followed and then they compaired result with that of ETABS.

**Varikuppala Krishna<sup>1</sup>, Rajashekar<sup>2</sup>:** They planned for a structure which consist of (parking+5floors). Design of the building was done as per norms which needs to be followed taking into consideration the vastu, site conditions. In their project they concluded that we can use light weight concrete materials so as to reduce the dead loads. They also concluded that Limit State Method of design is also the best method for design of the structure.

### III. METHODOLOGY

#### 3.1 *Design Philosophy*

Limit State Method takes into consideration both serviceability and safety of the structure. Thus we can conclude that this method is a combination of both Working Stress Method and Ultimate Stress Method.

The methodology followed for the design of G+5 building is:

- Preparing the AutoCAD drawings (plan, section and elevation) • Calculation of loads
- Analysis of the structure
- Design and detailing of structural elements.

The obtained plan of structure, its section as well as elevation of the buildings were drawn on Auto CAD 2013. Dead loads were obtained from unit weight of material given in IS 875 (Part I): 1987. Live loads were found from IS 875 (Part II): 1987. Dimensions of beams and slabs were found out from the codes conforming to IS 456-2000. Universal Excel sheets are being prepared for the designing of ‘one way as well as two way continuous slab’.

#### 3.2 *Testing of Materials*

##### 3.2.1 *Mix Design*

By conducting respective tests we found the density of the materials and other following properties using mix design by IS Code method :

$$\text{Cement} = 428.6 \text{ Kg/m}^3$$

$$\text{Water} = 197.16 \text{ Kg/m}^3$$

$$\text{Fine aggregate} = 644.9 \text{ Kg/m}^3$$

$$\text{Coarse aggregate} = 1151.5 \text{ Kg/m}^3$$

$$\text{Admixture} = 0.2 \text{ Kg/m}^3$$

W/C ratio = 0.46

**Table 3.1: Mix Design Parameters by IS Method**

Cement	Fine aggregate	Coarse Aggregate		Water
10 Kg	14.9 Kg	26.7 Kg		4.7 Kg
		16.02Kg	10.68Kg	

3.2.2 Particle size distribution of Fine Aggregate and Coarse Aggregate

**Table 3.3: Particle size distribution of Coarse Aggregate**

IS Sieve	Weight Retained on Sieve (gm)	Percentage of Weight Retained (%)	Cumulative weight retained
80 mm	0	0	0
40 mm	0.328	6.56	6.56
20 mm	1.381	27.62	34.18
10 mm	2.839	56.78	90.96
4.75mm	0.45	9	99.96

The fineness modulus of the coarse aggregate is 7.31

**Table 3.4: Particle size distribution of Fine Aggregate**

IS SIEVE	Weight Retained on sieve (gm)	Percentage of Weight Retained	Percentage of Weight Passing(%)	Cumulative weight retained
10.00 mm	0	0	100	0
4.75mm	0	0	100	0
2.36 mm	0.349	7.45	82.55	17.45
1.18 mm	0.509	25.45	57.1	42.9
600 micron	0.421	21.02	36.05	63.95
300 micron	0.483	24.15	11.9	88.1
150 micron	0.134	6.7	5.2	94.8

Fineness modulus of a given sample of fine aggregate is 3.072 that indicate fine sand.

The given sample of fine aggregate belongs to Grading Zone-2.

#### IV. ANALYSIS

##### 4.1 AutoCAD Plan

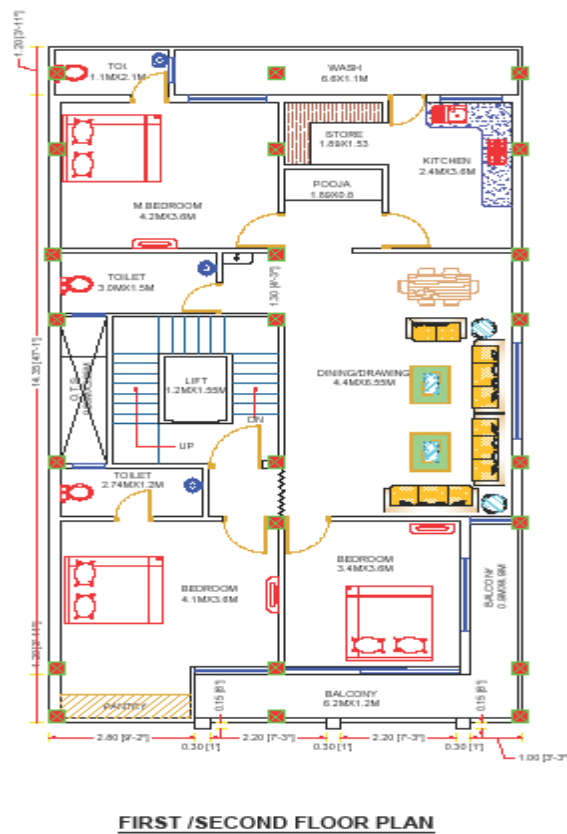
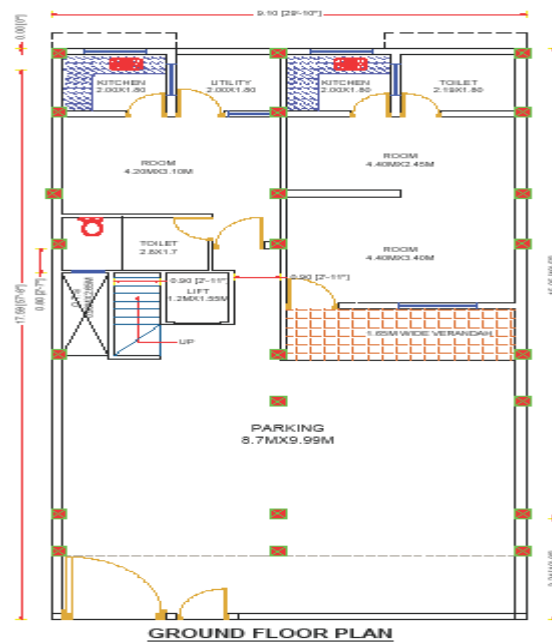
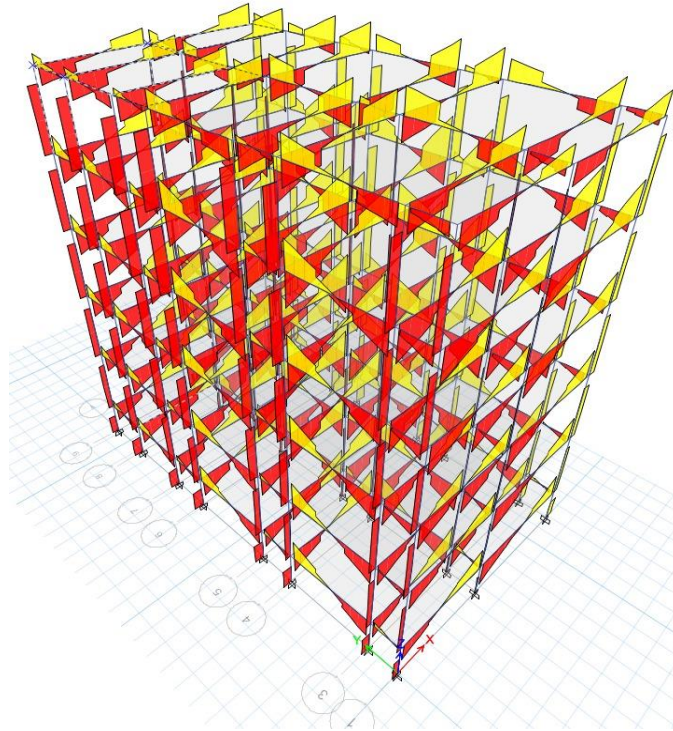
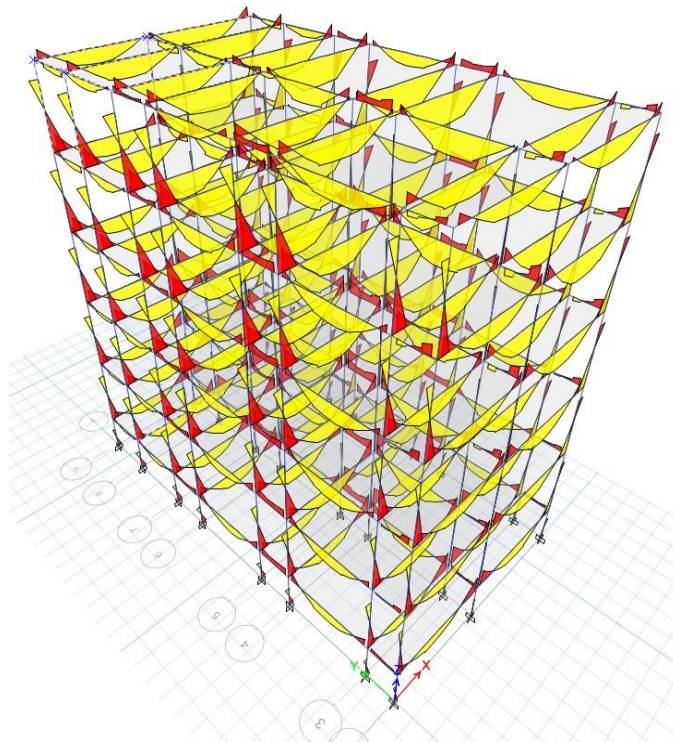


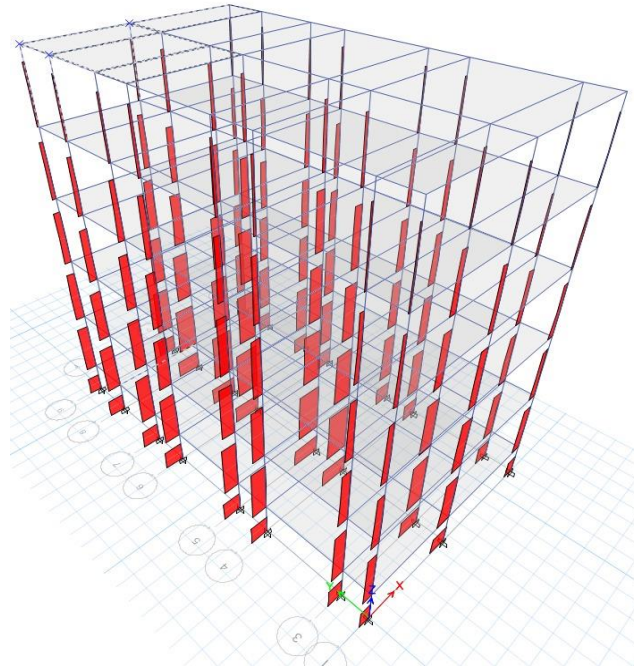
Fig 1.1 – AutoCAD Floor Plan



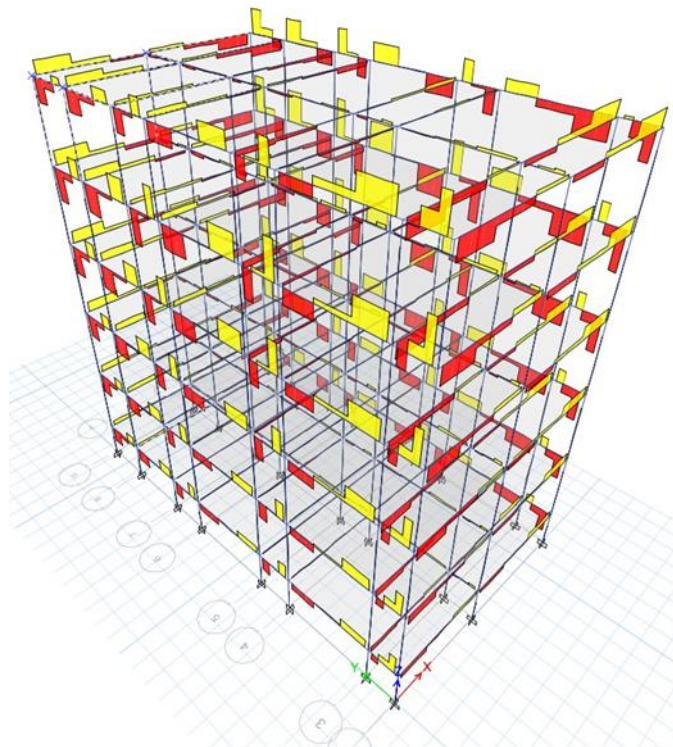
**Fig 1.2 – Shear Force Diagram**



**Fig 1.3 – Bending Moment Diagram**



**Fig 1.4 – Axial Force Diagram**



**Fig 1.5 – Torsion Diagram**

## V. CONCLUSION

5.1 Column and beams were provided in structure of the size as mentioned below:

Column = 300 X 300 mm

Beam = 200 X 600 mm

5.2 As our project is based on most economical column method so we will do it by reducing the size of section. As load is more at bottom as compared to top there is no need of providing big size column at top.

5.3 We can economize the column by providing it in the required amount as specified by IS Codes. Minimum percentage Area of steel is usually 0.8% of the Gross cross sectional area and maximum area is taken as 6% as per IS code.

5.4 We can Economize the column by means of orienting the column in such a way that, longer span with longer direction will reduce the bending in structure as a result area of steel required is also reduced.

5.5 As the height of structure is increased, the stiffness phenomenon (slenderness effect) i.e. long column effect will come into account. Thus the result will show amount of deflection far greater than the codal provisions (IS – 456).

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