# Analysis and Design of Commercial Building Using ETABS

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***Abstract*- The structural analysis is the branch which involves in the determination of behaviour of structures in order to predict the responses of different structural component due to effect of loads. Our project "Analysis and Design of Commercial Building Using ETABS Software" is an attempt to analyze and design a commercial building using ETABS. A G+2 storey Commercial building is considered for this study. Analysis is carried out by static method and design is done as per IS 456:2000 guidelines and we have checked for the displacement, storey-drift, deflection and maximum percentage of steel are all with in the permissible limits.**

## I. INTRODUCTION

The term building in Civil Engineering is used to mean a structure having various component like foundation, walls, columns, floors, doors, windows, ventilators, stairs, lifts, various type of surface finishes etc. Structural analysis and design are used to produce a structure capable of resisting all applied loads without failure during its intended life. Structures engineers are facing the challenges of striving for most efficient and economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design life time. The effective design and construction of structures have much greater importance in all over the world therefore engineers are trying to use different materials to their best advantage keeping in view the unique properties of each material structurally robust and aesthetically pleasing building are being constructed by combining the best properties at the individual material and at the same time meeting the specify requirements of large span, building load, soil condition, time, flexibility and economy high rise buildings are the best suited solution.

The effective design and construction of earthquake resistant structures have much greater importance in all over the world therefore engineers are trying to use different materials to their best advantage keeping in view the unique properties of each material structurally robust and aesthetically pleasing building are being constructed by combining the best properties at individual material and at the same time meeting the specific requirements of large span, building load, soil condition, time, flexibility and economy high rise buildings are best suited solution.

As our country is the fastest growing country across the globe so the need of shelter for highly populated cities where the cost of land is high and further horizontal expansion is not possible due to unavailability of space, so the only solution is vertical expansion. After an earthquake occurs it causes great damage due to unpredictable seismic motion striking & when the height of building is increased the wind load effect also acts on building. This causes and should have sufficient stiffness and strength to control displacement at supports. However, it is inappropriate to design a structure to remain in the elastic region, under severe earthquakes & wind lateral forces, because of the economic constraints.

### OBJECTIVES

From the above literature review the following objectives are made;

- The main objective of this study is to analyze and design a G+2 commercial building using ETABS software.
- To design structural components like beam, slab, column and footing using ETABS.
- Comparison of results obtained from ETABS software with IS code.

## 2. LITERATURE REVIEW

Ragy Jose, Restina Mathew, Sandra, Mohit Y S and Sankerthana Venu (2017) "Analysis and Design of Commercial Building by ETABS". Structural Analysis is a branch which involves in the determination of behaviour of structures in order to predict the responses of different structural components due to effect of loads. Each and every structure will be subjected to either one or the groups of loads, the various kinds of loads normally considered are dead load, live load, earth quake load and wind load. ETABS is a software which is incorporated with all the major analysis engines that is static, dynamic, Linear and non-linear, etc. and especially this Software is used to analyze and design the buildings. Our project "Analysis and Design of Commercial building using ETABS software" is an attempt to analyze and design a commercial building using ETABS A G+3 storey building is considered for this study. Analysis is carried out by static method and design is done as per IS 456:2000. They have concluded that, Analysis was done by using ETABS software and successfully verified as per IS 456:2000, Usages of ETABS software minimize the time required for analysis and design and as the 4-storey building has similar floors ETABS is the perfect software which can be adopted for analysis and design.

Ali Kadhim Sallal (2018) "Analysis and Design of 10 storey building using ETABS". A G+9 storey building is considered for this study. This paper presents a building where designed and analysed under effect of earthquake and wind pressure by using ETABS software. Analysis is carried out by using ETABS. They have concluded that, the values of dead, live, floor finish loads obtained by the ETABS program are similar to the IS Code, various important results like bending moments, shear force and deflection results are carried out using ETABS.

Omprakash, S. Tousif Ehtesham, C MD Faraaz, Shaik Shabbir Basha, Shaik Riyaz (2018) An earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Effects are often classified as primary and secondary impacts. Primary effects occur as a direct result of the ground shaking, e.g. buildings collapsing. Secondary effects occur as a result of the primary effects, e.g. tsunamis or fires due to ruptured gas mains. In structural engineering, a bracings is a lateral load system composed to counter the effects of lateral load acting on a structure. Bracings are structural members used to augment the strength of RCC structures. These bracings will be built in each elevation of the structure, to form an effective structure. In the present work "Analysis and Design of Commercial building with bracings using ETABS" is an attempt to analyse and design a commercial building using ETABS. A G+9 storey building is considered for this study. Analysis is carried out by static method and design is done as per IS 456:2000 guidelines. For the analysis of the building for seismic loading with two different Zones (Zone-III & Zone-V) is considered with all three soil types. The results from the analysis are obtained in static method and are presented in tabular form and the results are compared using graphical form. The have concluded that, the structure performance is analysed in two different models I.e. without bracing and with bracing of X shape, the displacement of 50% is reduced when lateral system are provided and Zone wise comparison in made for each soil and it is observed that average of 50% is reduced in displacement, shear, moment.

M Mallikarjun, Dr P V Suraya Prakash (2016) Hyderabad is the fifth largest city in our country. As it is rapidly developing in the field of construction in the city is very costly. The design process of structural planning and design requires not only imaginations and conceptual thinking but also a sound full knowledge on how a structural engineer can economies the structure besides the knowledge of practical aspects, such as recent design codes, bye laws, experience, intuition and judgment. The main purpose of the project is to ensure and enhance the safety, keeping careful balance between economy and safety. The analysis and design for the structure done by using a software package etabs.in this project multi-storeyed construction, we have adopted limit state method of analysis and design the structure. The design is in confirmation with is 456-2000.the analysis of frame is worked out by using ETABS. They have concluded that, Economizing the column by means of area of steel as per IS code and we have designed the structure in an economical way by reducing the size of section.

## 3. METHODOLOGY

ETABS is an engineering software product that caters to multi-story building analysis and design. “Its full form is extended three-Dimensional analysis of building system”.

ETABS is a special-purpose computer program developed specifically for building structures. It provides the Structural Engineer with all the tools necessary to create, modify, analyze, design, and optimize building models. These features are fully integrated in a single, Windows-based, graphical user interface that is unmatched in terms of ease-of- use, productivity, and capability.

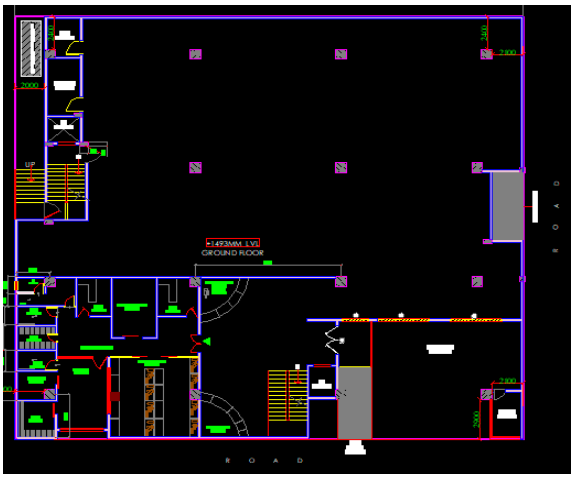

Fig 1: Plan of Ground Floor

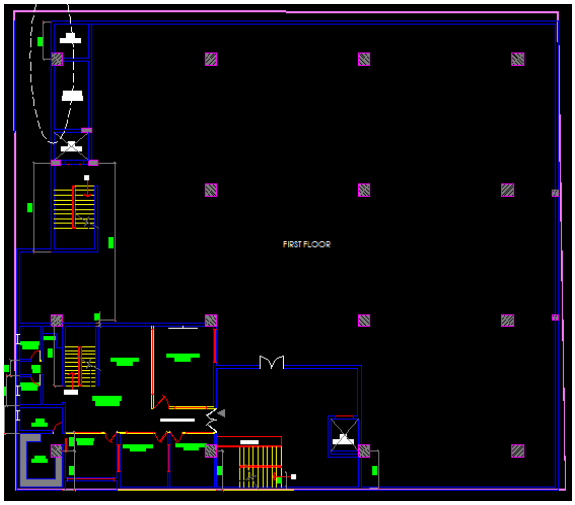

Fig 2: Plan of First Floor & second floor

Table 1 Beam Details

| | |
|---|---|
| Beam 1 | 200x450 mm |
| Beam 2 | 200x600 mm |
| Beam 3 | 200x800 mm |
| Beam 4 | 300x600 mm |
| Beam 5 | 300x700 mm |
| Beam 6 | 350x750 mm |

Table 2 Column Details

| | |
|---|---|
| Column 1 | 200x450 mm |
| Column 2 | 200x600 mm |
| Column 3 | 375x375 mm |
| Column 4 | 375x600 mm |
| Column 5 | 750x750 mm |

Table 3 Slab Details

| | |
|---|---|
| Material | Concrete (M25 & M30) |
| Type | Membrane |
| Thickness | 150 mm |

Loads

For wall

Wall load = (floor ht.-beam depth) x width of wall x density of brick

= (4 – 0.45) x 0.2 x 15

= 10.65 KN/$m^2$

For slab from IS: 875 (part 2) – 1987

Live load for toilets = 2.0 KN/$m^2$

Live load for kitchen = 3.0 KN/$m^2$

Live load for staircase = 4.0 KN/$m^2$

Live load for passage = 5.0 KN/$m^2$

Live load for dining room = 3.0 KN/$m^2$

Live load for cabin = 2.5 KN/$m^2$

Live load for storage = 6.0KN/$m^2$

Load Combinations: For seismic load analysis of a building the code refers following load combination.

1. 1.5(DL + IL)
2. 1.2(DL + IL ± EL)
3. 1.5(DL ± EL)
4. 0.9 DL ± 1.5 EL

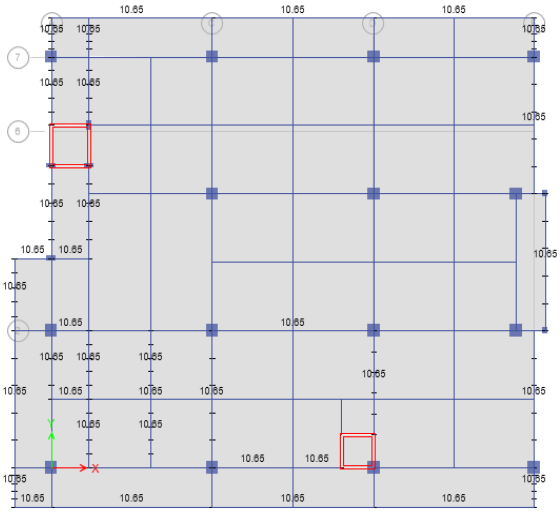

Fig 3 : Beam, Column and Slab with Wall Load

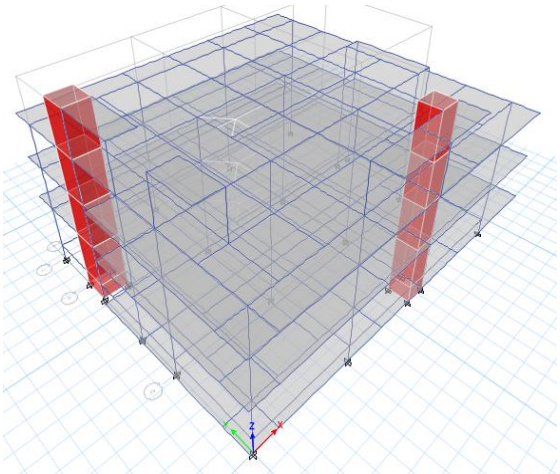

Fig 4: Deformed Shape of Building After Analysis

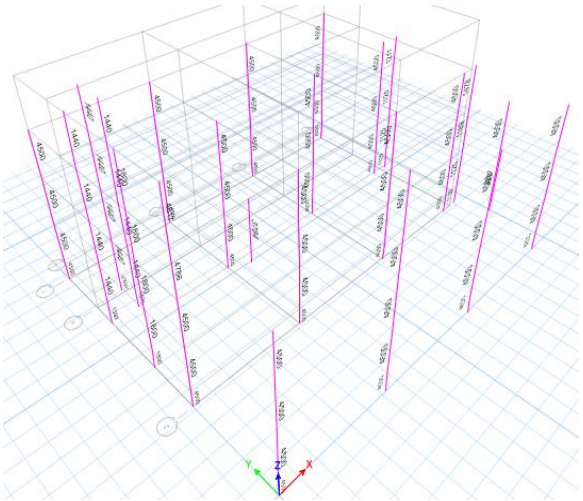

Fig 5: Designed Columns

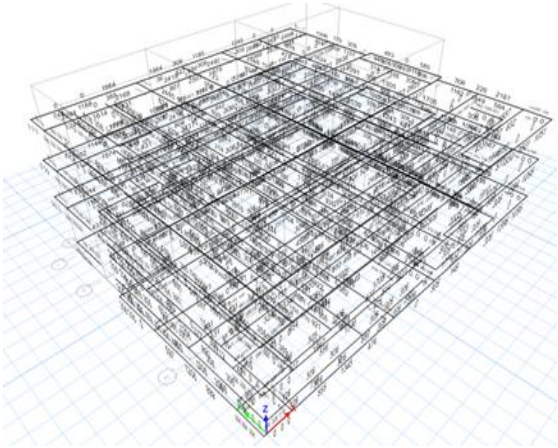

Fig 6: Designed Beam

## 4. RESULTS AND DISCUSSIONS

Shear Force:

Shear force is force applied perpendicular to a surface, in opposition to an offset force acting in the opposite direction. This results in a shear strain. In simple term, one part of the surface is pushed in one direction, while another part of the surface is pushed in the opposite direction.

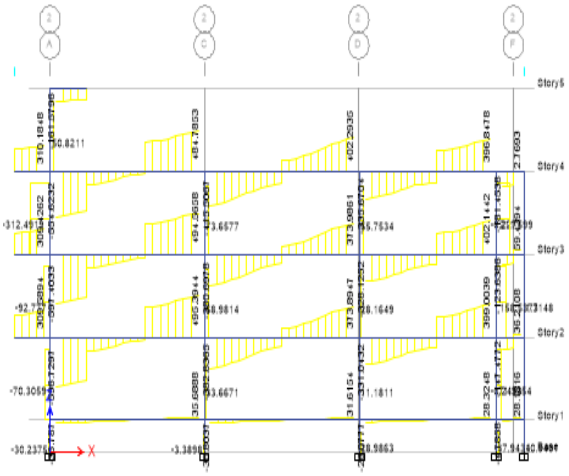


Fig 7: SFD in Elevation View

Bending Moment Diagram:

Bending moment is a measure of the bending effect that can occur when an external force or moment is applied to a structural element. This concept is important in structural engineering as it can be used to calculate where, and how much bending may occur when forces are applied.

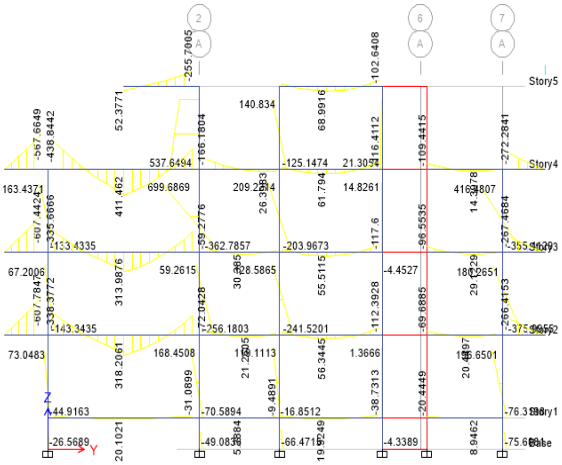


Fig 8: BMD in Elevation View

Displacement:

It is total displacement of its storey with respect to ground and there is maximum permissible limit prescribed in IS codes for buildings

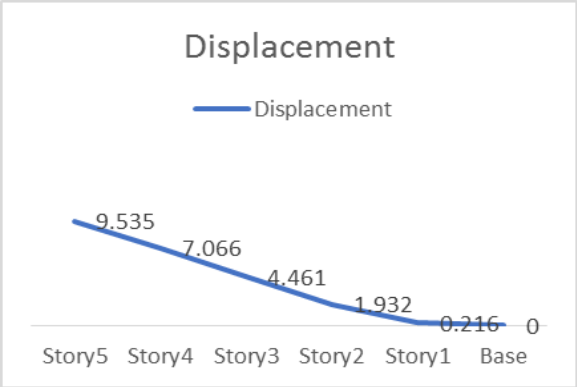


Fig 9: Displacement

Storey Drift:

It is defined as ratio of displacement of two consecutive floor to height of that floor. It is very important term used for research purpose in earthquake engineering. The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0, shall not exceed 0.004 times the storey height.

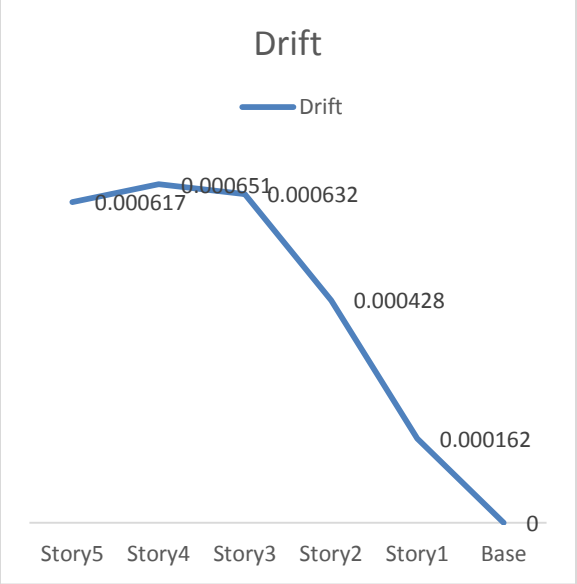


Fig 10: Storey Drift

Maximum Percentage of Steel in Columns and Beams:

In IS 456:2000 Clause 26, requirement related to reinforcement used in RCC is given. In beams, slabs maximum percentage of steel is 4% of gross area. In column maximum % of steel is 4%. All the columns and beams shown in figure below is within the permissible limit i.e. less than 4%.

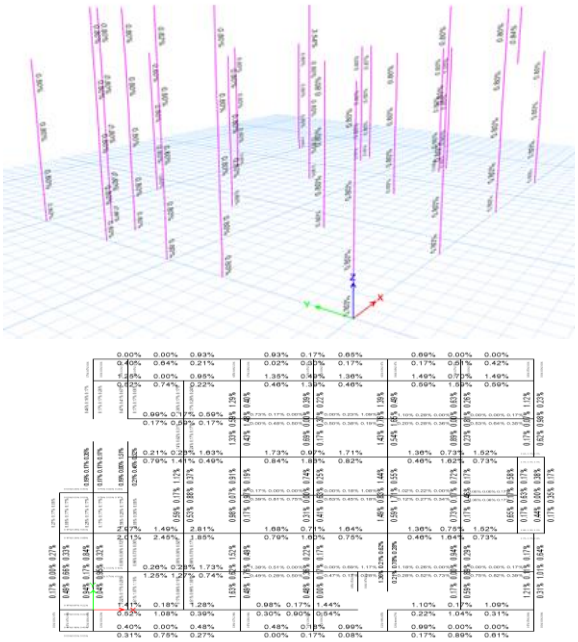

Fig 11: Percentage of steel for Column and Beam

Deflection:

The deflection at any point on the axis of beam is the distance between its position before and after loading.

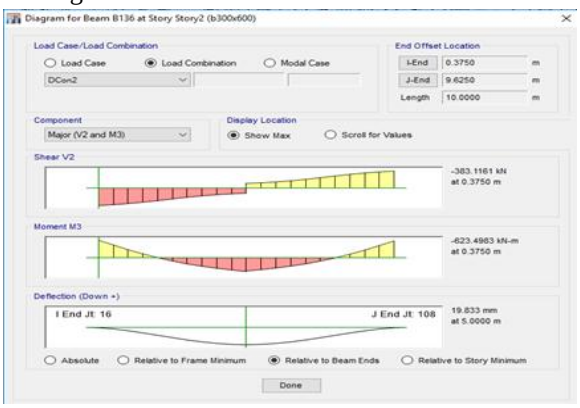


Fig 12: Deflection of Beam

## 5.CONCLUSION

From the data revealed by the software analysis for the structure following conclusions are drawn:

1. Analysis was done by using ETABS software and successfully verified as per IS456:2000.
2. Calculation by software analysis gives results within the premissible limit according to IS code.
3. Further the work is extended for a -storey building and found that the results are matching.

4. As the 3-storey building has similar floors ETABS is the perfect software which can be adopted for analysis and design.
5. Usage of ETABS software minimizes the time required for analysis and design.
6. We can easily add and remove the storey of the building

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INDIAN STANDARD CODES

1. IS: 456-2000 "Indian Standard code of practice for plain and reinforced Cement Concrete", Bureau of Indian Standards, New Delhi.
2. IS: 875 (Part 2): 1987 "Indian Standard code of practice for design loads for buildings and structures, Bureau of Indian Standards, New Delhi.
3. IS: 1893 (Part 1): "Indian Standard code of practice for criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi.

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